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Analytical results for 35 mine-waste tailings cores and six bed-sediment samples, and an estimate of the volume of contaminated material at Buckeye meadow on upper Basir Creek, northern Jefferson County, Montana

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ABSTRACT

Metal-mining related wastes in the Boulder River basin study area in northern Jefferson County, Montana have been implicated in their detrimental effects on water quality with regard to acid-generation and toxic-metal solubilization. Flotation-mill tailings in the meadow below the Buckeye mine, hereafter referred to as the Buckeye mill-tailings site, have been identified as significant contributors to water quality degradation of Basin Creek, Montana. Basin Creek is one of three tributaries to the Boulder River in the study area; bed sediments and waters draining from the Buckeye mine have also been implicated. Geochemical analysis of 35 tailings cores and six bed-sediment samples was undertaken to determine the concentrations of Ag, As, Cd, Cu, Pb, and Zn present in these materials. These elements are environmentally significant, in that they can be toxic to fish and/or the invertebrate organisms that constitute their food. A suite of one-inch cores of dispersed flotation-mill tailings and underlying pre-mining material was taken from a large, flat area north of Basin Creek near the site of the Buckeye mine. Thirty-five core samples were taken and divided into 204 subsamples. The samples were analyzed by ICP-AES (inductively coupled plasma-atomic emission spectroscopy) using a mixed-acid digestion. Results of the core analyses show that the elements listed above are present at moderate to very high concentrations (arsenic to 63,000 ppm, silver to 290 ppm, cadmium to 370 ppm, copper to 4,800 ppm, lead to 93,000 ppm, and zinc to 23,000 ppm). Volume calculations indicate that an estimated 8,400 metric tons of contaminated material are present at the site. Six bed-sediment samples were also subjected to the mixed-acid total digestion, and a warm (50°C) 2M HCl-1% H_2O_2 leach and analyzed by ICP-AES. Results indicate that bed sediments of Basin Creek are only slightly impacted by past mining above the Buckeye-Enterprise complex, moderately impacted at the upper (eastern) end of the tailings area, and heavily impacted at the lower (western) end of the area and downstream. The metals are mostly contained in the 2M HCl-1% H_2O_2 leachable phase, which are the hydrous amorphous iron- and manganese-hydroxide coatings on detrital sediment particles.

INTRODUCTION

Metal-mining related wastes in the Boulder River basin study area in northern Jefferson County, Montana have been implicated in their detrimental effects on water quality with regard to acid generation and toxic-metal solubilization during snow melt and storm water runoff events (Buxton and others, 1997). The bed sediments and waters of Basin Creek have been impacted by contamination from mine waste and tailings from the Buckeye-Enterprise mining and milling complex (Metesh and others, 1994). Basin Creek is one of three major tributaries to the Poulder River in the study area, (see figure 1) and is a contributor to water quality degradation of the Boulder River. During the late 1800's and early 1900's, the Buckeye and the Enterprise mines were worked together, and both used an on-site gravity mill to concentrate ore. The mined ore contained pyrite, arsenopyrite, galena, sphalerite, and tourmaline. During World War II, a flotation mill was built in the floodplain of Basin Creek to re-process the gravity tailings from the old mill (Metesh and others, 1994). The Buckeye-Enterprise mine/mill complex was assessed for possible listing in the National Register of Historic Places; such listing could affect reclamation actions. As a result of the collapsed state of most of the mining related structures, and lack of significant architectural or engineering features, the complex was not recommended for listing. (Rossillon and Haynes, 1999). The mass of the reprocessed flotation tailings was estimated at 16,000 tons (Metesh and others, 1994). These tailings have dispersed over a wide area (about 3.3 acres) whose southern edge is bounded by Basin Creek. Desborough and Fey (1997) studied waste material from nine mine sites in the Basin district and produced a qualitative scale for potential water-quality degradation resulting from these wastes. The scale was based on the combined effect of acid-generation potential, dissolved toxic metals from a passive leach, and estimated tonnage. Tailings produced by the flotation mill process in the floodplain of Basir Creek scored a nine on a scale of one (low) to nine (high). These tailings are the subject of this investigation. This report presents analytical results for total-digestion elemental content for 35 cores, and the total-digestion elemental content, leachable elemental content, and the total-digestion elemental content of leach residues for six stream sediments. A similar report covered the fluvial tailings present in High Ore Creek, downstream from the Comet mine (Fey and Church, 1998).

METHODS OF STUDY

Sample Collection

All samples were collected from or near Basin Creek, (T8N R6W Section 36) located on the Three Brothers, Montana USGS 1:24,000 topographic map.

Stream sediments

In October 1996, we collected 47 bed-sediment samples in the Boulder River basin, including one from Basin Creek west and outside of the Buckeye tailings study area. In July 1997, we collected four additional bed-sediment samples from Basin Creek on the eastern and southern edges of the tailings area. In July 1998, we collected one additional bed-sediment sample on Basin Creek upstream of the tailings area and mine workings, for a total of six bed sediments from the Buckeye tailings site (figure 2). Analyses of bed-sediment samples represent the chem-

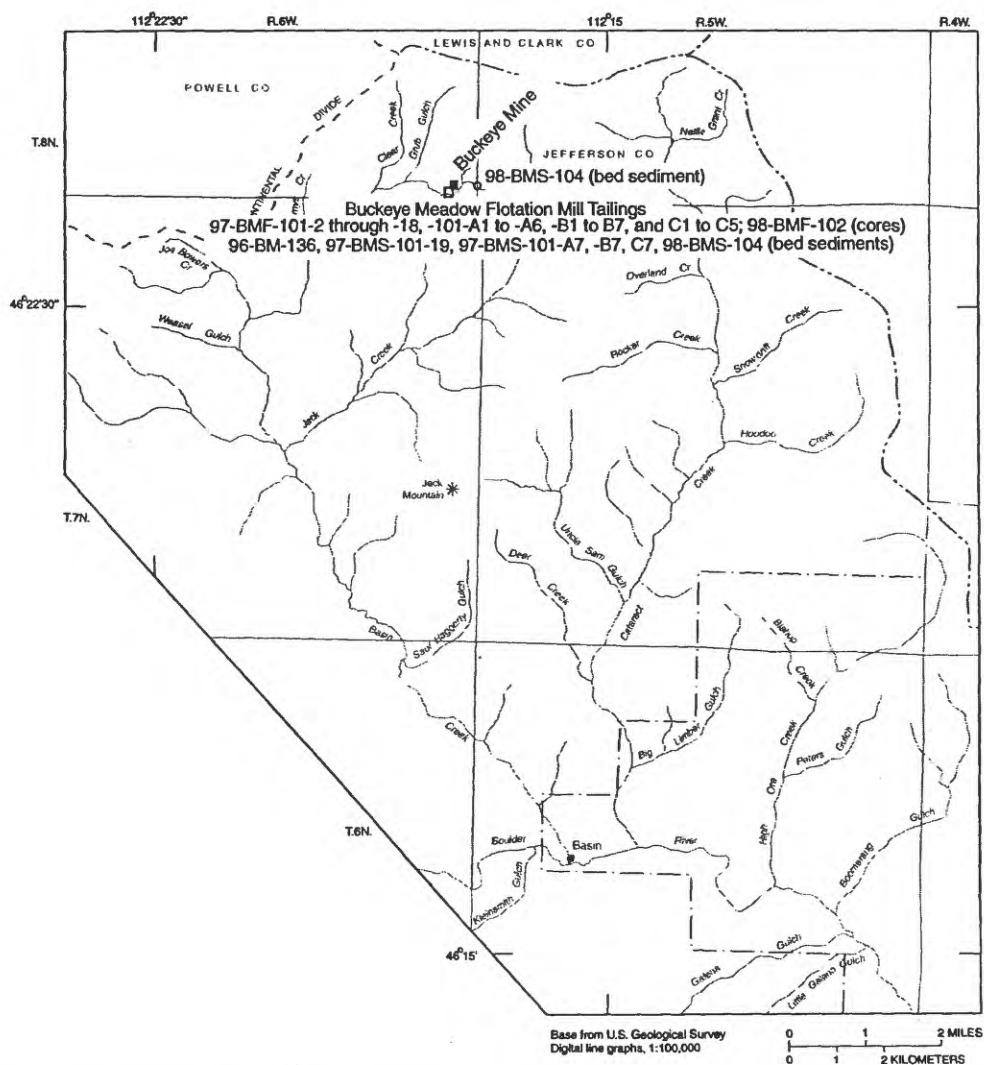
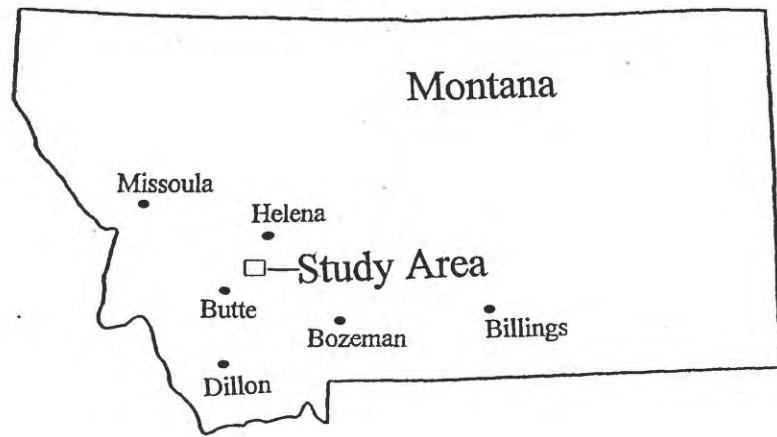


Figure 1. Index map of Montana showing Boulder River study area and sample location map for flotation mill-tailings cores and bed sediments from Buckeye meadow area

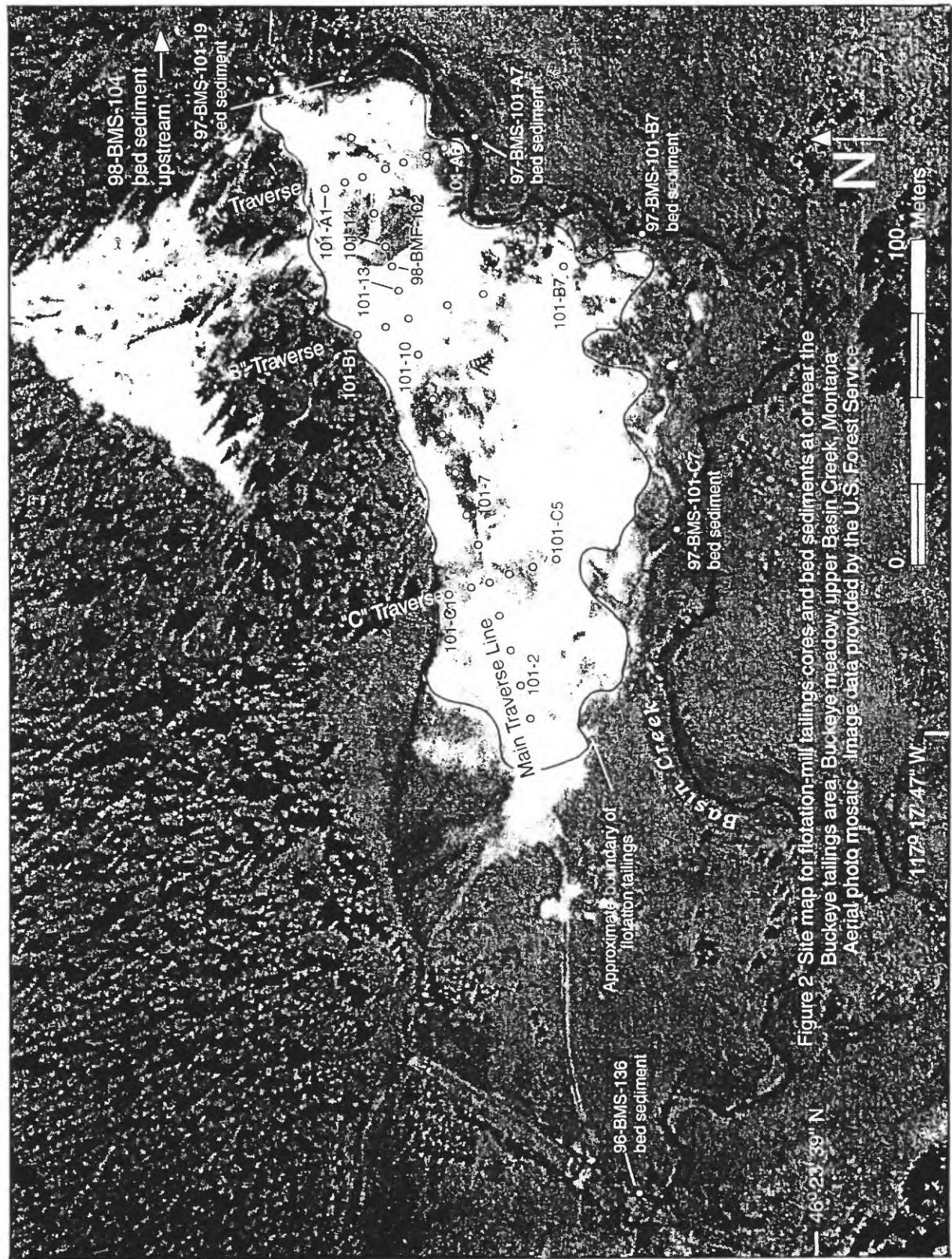


Figure 2 Site map for flotation-mill tailings cores and bed sediments at or near the Buckeye tailings area, Buckeye meadow, Upper Basin Creek, Montana. Aerial photo mosaic. Image data provided by the U.S. Forest Service.

istry of material eroded upstream of the sample site and from colloidal material coating the detrital grains. An integrated bed-sediment sample was collected at each site by compositing 10 to 20 individual subsites within 15 m (50 ft.) of the plotted site, and collecting material from the active channel alluvium. In the field, each composited sample was sieved through a 2 mm (10 mesh) stainless steel screen, and the minus-2mm fraction retained; the larger fractions were discarded.

Fluvial Tailings Cores

In July 1997, we collected a suite of 34 one-inch diameter cores from the north flood plain of Basin Creek (not the active stream channel). This suite is identified as 97-BMF-101. The samples were collected along a traverse bearing N74°E for approximately 200 meters (650 feet) starting from the west end of the tailings area, and from three traverses (A, B, and C) perpendicular to the main line (figure 2). All samples were collected in plastic core tubes using a stainless-steel soil probe/sampler to depths up to 65 cm, the maximum penetration of a single probe. Typical depths were 50 to 60 cm. Core penetration depth and actual length were recorded on-site to determine the amount of compression. An additional core was collected from the bottom of a four-foot-deep trench in July 1998. The configuration of the site, core locations, and traverses are shown in figure 2.

Sample Preparation

Stream-sediment samples

Bed-sediment samples were dried at ambient room temperature (25°C) and sieved to minus-80-mesh (<.18 mm) prior to laboratory analyses.

Flotation-tailings-core samples

Core samples were subdivided in the laboratory into subsamples (by depth) according to visual identification of differences in mineralogy, organic content, and apparent oxidation zones. See table 4 for subsample descriptions and their depths within cores. A core compaction factor was incorporated to determine the actual depth of the subsamples; the assigned depth for each is defined as the midpoint of that subsample. The cores were subdivided into two to ten subsamples, typically about five. These subsamples were then placed in a random order and ground using a vertical pulverizer with ceramic plates to minus 100-mesh (<0.15mm). Thirty-four cores were collected from site 97-BMF-101 and these were divided into 196 subsamples. The core from 1998, 98-BMF-102, was divided into eight subsamples.

Sample Analysis

Total digestion ICP analysis for 32 elements

The six bed-sediment samples, leach residues for the six bed-sediment samples from the partial extraction described below, and 204 core subsamples were digested with a mixed-acid procedure consisting of HCl, HNO₃, HClO₄, and HF, and analyzed for 32 elements by ICP-AES (inductively coupled plasma-atomic emission spectroscopy) (Crock and others, 1983; Priggs, 1996). This procedure is effective in dissolving most minerals, including silicates, oxides and sulfides; resistant or refractory minerals such as zircon, chromite, and some tin oxides are only partially dissolved. Previous investigations using a variety of materials support the completeness

of the digestion (Church and others, 1987; Wilson and others, 1994). The values for total-digestion analyses for the cores are given in table 5, and the values for total-digestion analyses for the bed sediments are given in table 6. Limits of determination for the total digestion method are given in table A7 in the Appendix. Comparisons of values observed for three National Institute of Standards and Technology (NIST) standard reference materials (SRM-2704, SRM-2709 and SRM-2711) with certified values (NIST, 1993a, 1993b, and 1993c) are given in tables A1 through A6 in the Appendix.

Warm 2M HCl-1% H₂O₂ leach extraction

The use of a partial-digestion extraction enables one to determine concentrations of trace elements bound within different phases, whereas a total digestion releases all trace elements in a sample (Chao, 1984). The six bed sediments from Basin Creek were subjected to a partial-digestion extraction consisting of warm (50° C) 2M HCl-1% H₂O₂ for three hours with continuous agitation; the leachates were subsequently analyzed by ICP-AES for 29 elements. This partial extraction releases trace elements associated with hydrous amorphous iron- and manganese-oxide mineral coatings and colloidal particles (Appendix III of Church and others, 1993; Church and others, 1997). Mineral coatings such as those observed in Basin Creek can contain a significant percentage of the trace elements in a sample (Church and others, 1997). The residues from this extraction were then dried, weighed, and subjected to the total digestion described above to determine trace element concentrations bound in the oxide, silicate, and more-resistant sulfide phases. The data obtained from the 2M HCl-1% H₂O₂ extraction are presented in table 7, and the data for the total digestion of the residues are given in table 8. Analytical limits of determination for the partial-digestion leach method are given in table A7 in the Appendix.

Site Descriptions

Stream sediments

Locations of the bed-sediment sample sites are given in table 1 and are shown on figure 2. Bed-sediment sample 96-BM-136 is located downstream of the tailings area, just east of a 4WD road that crosses Basin Creek. Sample sites 97-BMS-101-C7, -B7, and -A7 are located on Basin Creek, where the three perpendicular core traverses meet with the creek. Site 97-BMS-101-19 is located on the creek, at the far eastern end of the tailings area, and where the main core traverse meets the creek. Site 98-BMS-104 is located upstream from the Buckeye mine, about 0.2 km (700 ft.) east of the confluence of Basin Creek with a small, unnamed northern tributary.

Flotation-tailings cores

The locations of the flotation-tailings cores and the configuration of the traverses are shown in figure 2. Seventeen core samples (cores 97-BMF-101-2 through -101-18) were collected from the main traverse, spaced 12 meters (40 feet) apart. No core was taken at site 1, as tailings material was essentially absent at that point. The tailings are thickest (1.2 m or 4 ft) near the eastern part of the area, which consists of a topographic high. The topographic high is located between sites 97-BMF-101-13 and -101-14, about 60 m (200 ft) southwest of the sediment site 97-BMS-101-19, along the main sampling traverse. This point corresponds to the location of core 98-BMF-102

Traverse A is perpendicular to and crosses the main traverse between sites 15 and 16, and, along a bearing of N16°W. There are six samples from traverse A, starting at the upper (north) end. Two cores were collected north of the main traverse, and four cores were collected south of the main traverse. The spacing between these cores was 6 m (20 ft), except between 97-BMF-101A2 and -101A3, which were 12 m (40 ft) apart; no core was taken at the intersection of traverse A and the main traverse.

Traverse B crosses the main line at site 97-BMF-101-12. Traverse B is also perpendicular to the main traverse, and has the same bearing as Traverse A. The spacing between cores was 12 m (40 ft). Two cores (97-BMF-101B1 and -101B2) were collected north of the main line, and four cores (97-BMF-101B4 through -101B7) south of the main line. Site 97-BMF-101B3 is the same as the main traverse site 97-BMF-101-12, and so a second core was not taken at this site.

Traverse C is located near the western end of the main traverse, crossing at site 97-BMF-101-5. It is also perpendicular and has the same bearing as traverses A and B. Two cores (97-BMF-101C1 and -101C2) were collected north of the main line, and three (97-BMF-101C3, -101C4 and -101C5) were collected south of the main line. The spacing between cores on traverse C was 6 m (20 ft), except between 97-BMF-101C2 and C3, which was 12 m (40 ft). As with traverse B, a second (duplicating) core was not collected from the intersection of traverse C with the main line. The depths of each core subinterval, along with sample descriptions for each subsample, are given in table 4.

In July 1998, we dug trenches through the tailings with a track-mounted backhoe at several locations on the tailings area. The purpose of digging these trenches was to determine the depth of tailings, especially through the thickest section where sample cores from 1997 did not penetrate through the bottom, and to sample the lower part of the tailings. We took a core (98-BMF-102) from the bottom of one four-foot-deep trench that was located essentially at the high part of the topographic mound, the thickest part of the tailings. The subsample descriptions and depths for this core are also presented in table 4.

Table 1. Localities of bed-sediment sites and core 98-BMF-102, in decimal degrees.

Bed Sediment Field Number	N. Latitude	W. Longitude
96-BM-136	46.39471	112.29825
97-BMF-101-C7	46.39463	112.29557
97-BMF-101-B7	46.39472	112.29436
97-BMF-101-A7	46.39520	112.29398
97-BMF-101-19	46.39557	112.29374
98-BMS-104	46.39611	112.28944
Site 98-BMF-102, post site at high point of tailings mound	46.39541	112.29450

Discussion of Results

Tailings Cores

Examination of total digestion data (table 5) reveals that the majority of the core samples contain contamination from the environmentally important elements Ag, As, Cd, Cu, Pb, and Zn.

Along the main traverse, the maximum concentrations (in ppm) for the elements listed above are: silver 290; arsenic 63,000 (6.3 %); cadmium 370; copper 4800; lead 93,000 (9.3 %); zinc 28,000 (2.8 %). Along traverse A, the maximum concentrations (in ppm) for the elements listed above are: silver 100; arsenic 23,000 (2.3 %); cadmium 130; copper 470; lead 17,000 (1.7 %); zinc 420. Along Traverse B, the maximum concentrations (in ppm) for the listed elements are: silver 180; arsenic 24,000 (2.4 %); cadmium 130; copper 390; lead 31,000 (3.1 %); zinc 460. Along Traverse C, the maximum concentrations (in ppm) for the listed elements are: silver 150; arsenic 38,000 (3.8 %); cadmium 200; copper 1,200; lead 26,000 (2.6 %); zinc 530. In addition to the high concentrations of these trace elements, there is generally attenuation of the trace elements with depth. However, several cores, notably 97-BMF-101-13, 97-BMF-101-14, and 97-BMF-101-B1, do not penetrate below the level of contamination. This is illustrated by the failure of silver and lead to diminish by the cores' bottoms.

The subsample descriptions presented in table 4 generally include the depths in the cores where the samples contain sandy material with either fresh or oxidized micas. This material is sediment deposited by a meandering stream, and includes unmineralized material derived from the Butte quartz monzonite (oral commun., J. M. O'Neill, 1999). This stream deposit is often capped by a soil horizon, upon which the tailings were deposited. The depth to which the actual tailings material extends can be estimated by the behavior of silver, which is relatively immobile in these tailings cores. The depth at which the concentration of silver was not detected generally corresponds to the depth at which micas (and hence pre-tailings stream sand) are present. Some of the uppermost core samples also include the presence of micas, although this is probably the result of later sandy material being transported onto and mixed with the upper tailings. Numerous subsamples at depth contain charcoal and/or other organic matter, also indicating that these samples are below the original level of tailings.

The depth of contamination is deeper than the depth of the original tailings, as a result of the downward migration of trace elements from the tailings. This is illustrated most clearly by the downward decreases in concentrations of arsenic, cadmium, copper, and zinc. Lead, however, behaves in a fashion similar to silver, in that its concentrations do show significant attenuation with depth. We determined the depths of contamination based on the values shown below in table 2. These limits are operationally defined, and are approximately 10 to 50 times the crustal abundance concentrations. Note that the regional background values for lead and zinc are higher than crustal abundance. Crustal abundance data are from Fortescue (1992) and the regional background values are from our unpublished work in the Boulder study area.

Table 2 Element concentration cutoff values for determination of contamination

Element	Ag	Cd	Cu	Pb	Zn
Cut-off value	5 ppm	5 ppm	300 ppm	100 ppm	500 ppm
Crustal abundance	0.08 ppm	0.16 ppm	68 ppm	13 ppm	76 ppm
Ratio	62	31	4.4	8	7
Regional background	<2 ppm	<2 ppm	30 ppm	55 ppm	170 ppm

Arsenic concentration was not used in the determination of the depth of contamination. Although arsenic levels often diminish with depth in these samples, the concentrations in some cores, particularly from the eastern half of the tailings area, remain high (table 5). In those cores,

far greater depths would be required to reach regional baseline levels of arsenic. Bed sediments collected at and downstream of the tailings complex also show high arsenic levels (up to 4,500 ppm, as shown in table 6). However, despite the high concentrations of arsenic in the core material, their proximity to Basin Creek, and the high arsenic concentrations in the bed sediments, soluble arsenic in the stream water at low flow is not elevated. Metesh and others (1994, Appendix V) reported 2.4 µg/L (ppb) arsenic in stream water collected above the Buckeye-Enterprise complex, and 20 µg/L arsenic in stream water collected below the mines and tailings. Neither value exceeds EPA primary or secondary drinking water standards, or EPA chronic or acute aquatic life standards (Metesh and others, 1994, table 18). In contrast, concentrations in the stream-water sample collected below the mines and tailings did exceed the EPA chronic aquatic life standards for copper, lead, and zinc (Metesh and others, 1994, table 18). Therefore we used concentrations of copper, lead, and zinc, as well as silver and cadmium, but not arsenic, to delineate depth of contamination.

We used the element cutoffs to determine contamination depths by inspecting where each core's trace-metal values were all below the cutoffs; if any one of the five trace elements exceeded the cutoff, that core interval was considered contaminated. Table 3 presents the depths of contamination for each core as described. The profiles of the depths to the bottom of tailings, as determined by silver concentrations and the appearance of micaceous sand in the sample descriptions (dashed line), and the depths to bottom of contamination, as determined by the concentrations of cadmium, copper, lead, and zinc (solid line), are shown in figures 3-6.

Table 3 Thicknesses of contamination of tailings cores.

Core Number	Contamination thickness, cm	Core Number	Contamination thickness, cm
97BMF-101-2	57	97BMF-101-A1	23
97BMF-101-3	41	97BMF-101-A2	53
97BMF-101-4	23	97BMF-101-A3	51
97BMF-101-5	21	97BMF-101-A4	83
97BMF-101-6	60	97BMF-101-A5	52
97BMF-101-7	59	97BMF-101-A6	39
97BMF-101-8	45	97BMF-101-B1	30
97BMF-101-9	27	97BMF-101-B2	43
97BMF-101-10	42	97BMF-101-B4	55
97BMF-101-11	61	97BMF-101-B5	45
97BMF-101-12	63	97BMF-101-B6	15
97BMF-101-13	120	97BMF-101-B7	22
98BMF-102	160	97BMF-101-C1	64
97BMF-101-14	120	97BMF-101-C2	40
97BMF-101-15	85	97BMF-101-C3	26
97BMF-101-16	65	97BMF-101-C4	31
97BMF-101-17	75	97BMF-101-C5	72
97BMF-101-18	28		

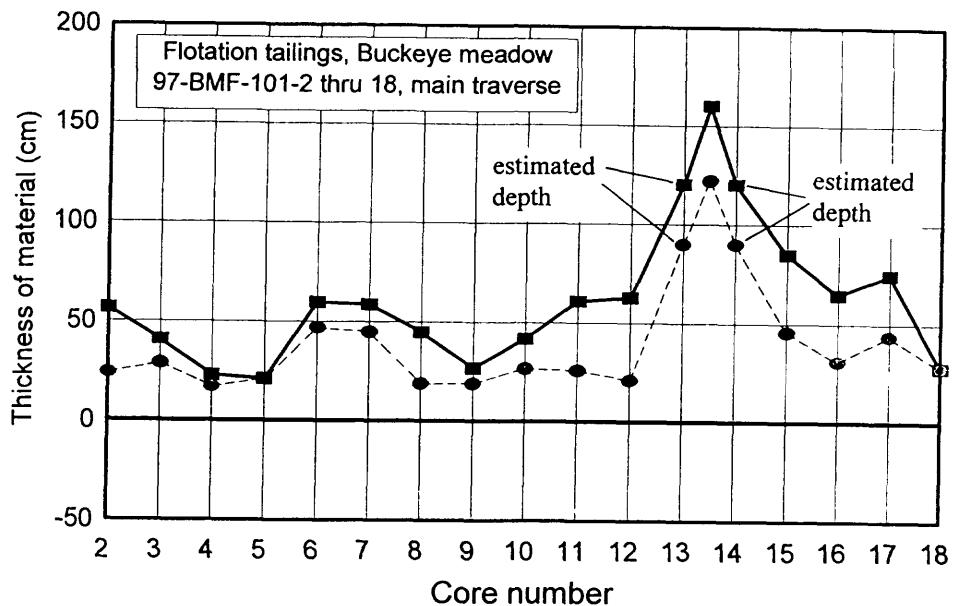


Figure 3 Thickness of tailings (dashed line and gray circles) and thickness of contamination (solid line and black squares) along main traverse line. Depths are estimated at cores 97-BMF-101-13 and -14.

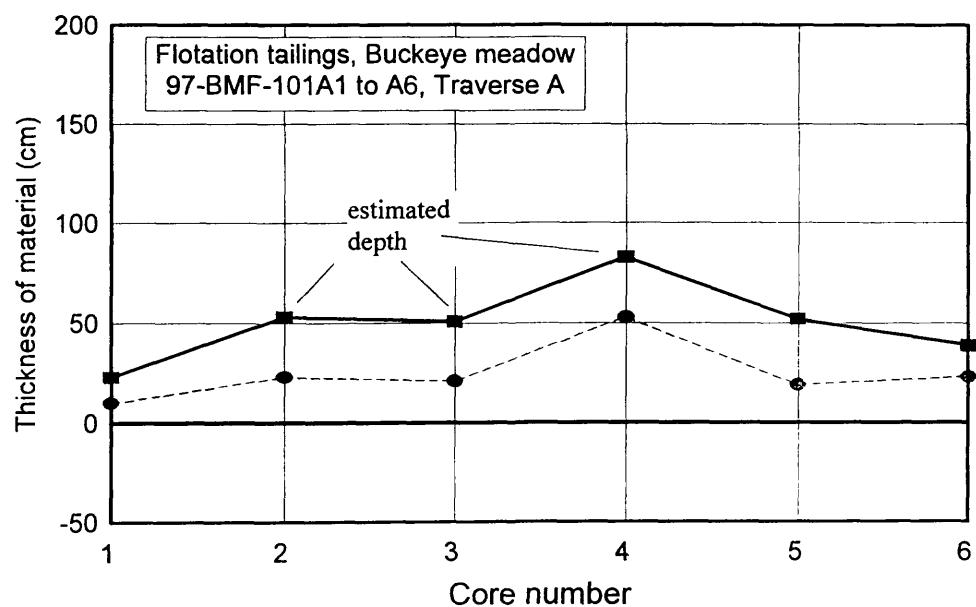


Figure 4 Thickness of tailings (dashed line and gray circles) and thickness of contamination (solid line and black squares) along traverse A. Depths are estimated at cores 97-BMF-101-A2, -A3, and -A4.

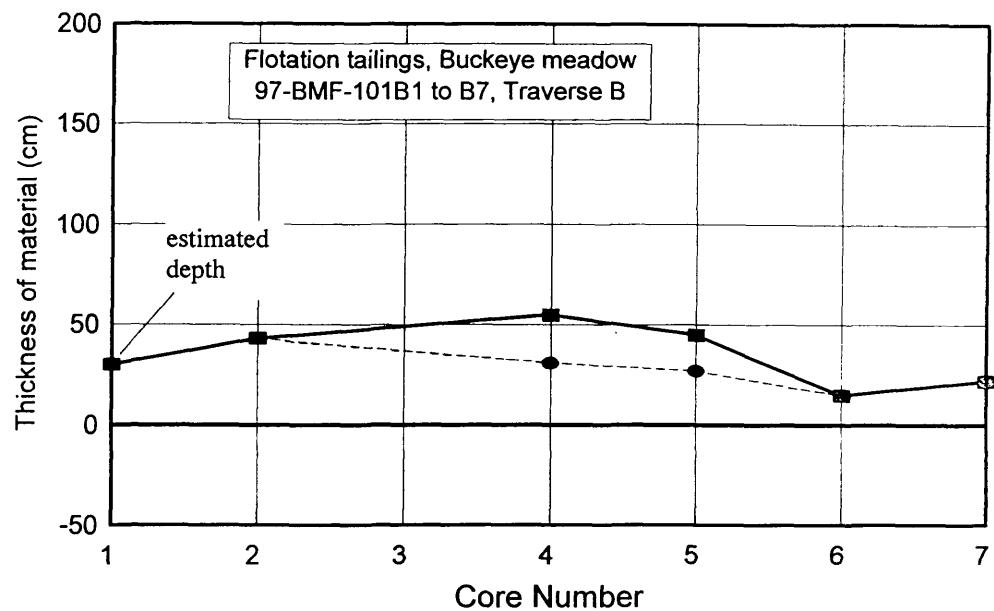


Figure 5 Thickness of tailings (dashed line and gray circles) and thickness of contamination (solid line and black squares) along main traverse line. Depth is estimated at core 97-BMF-101-B1.

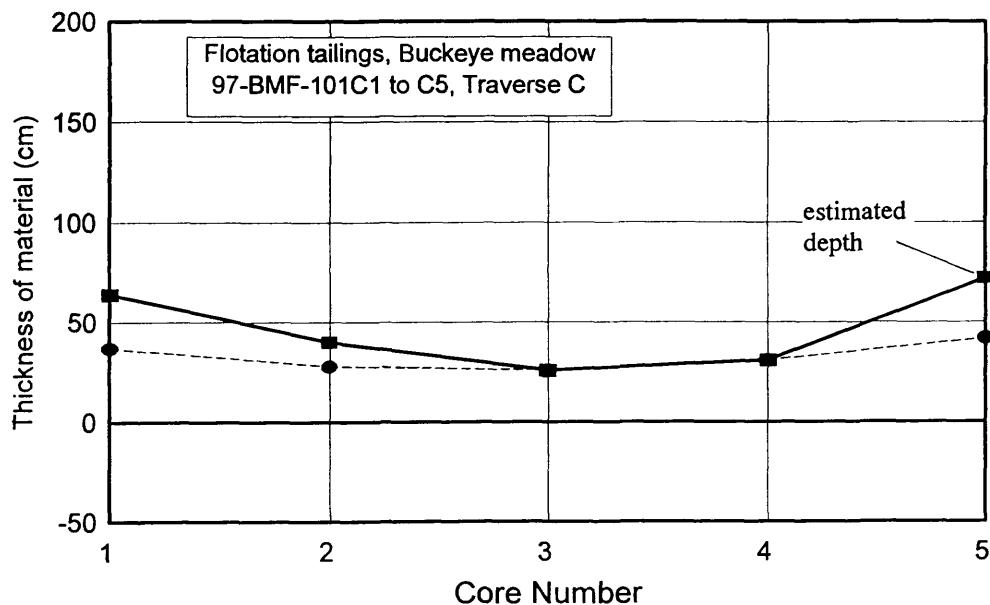


Figure 6 Thickness of tailings (dashed line and gray circles) and thickness of contamination (solid line and black squares) along traverse A. Depth is estimated at core 97-BMF-101-C5.

Main tailings traverse, cores 97-BMF-101-2 through 101-18

The profiles of the depth to bottom of tailings and the depth to the bottom of contamination for the main traverse line are shown in figure 3. The old soil horizon, or alternatively the original horizon marking the top of the micaceous sand, is probably relatively flat and planar, with the variation in depth profile related to the thickness of the tailings deposited on top of this sand. When the depths are plotted relative to a flat, planar datum, as shown in figure 3, the profile essentially reflects the topographic expression of the tailings at the surface. The datum chosen here is the average level at which the cores reached the micaceous sand layer between cores 2 and 5, about 24 cm (0.8 ft.). This is shown as the heavy horizontal line in figure 3. The tailings are generally quite shallow at the west end of the traverse, having a depth of less than 30 cm (1 ft.) between cores 2 and 5. The depth of contamination for the first four cores is between 20 and 60 cm (0.7 to 2 ft). The depth to the bottom of the tailings and the bottom of contamination increases at cores 6, 7 and 8, most likely due to topographic thickening. The thickness decreases at core 9, and then increases again between cores 10 and 12. The greatest thickness occurs between cores 13 and 14. These cores, taken from the surface in 1997, did not penetrate to the bottom of tailings or contamination. The subsequent core taken in 1998 (98-BMF-102) from the bottom of the four-foot-deep trench, located approximately at the high point of the topographic mound, and between cores 13 and 14, did penetrate through the tailings and trace-element migration-related contamination. This defines the deepest and thickest zone of tailings, and the deepest level of contamination of about 160 cm (5.2 ft.).

Cores 15 through 17 did penetrate to below the level of silver, but did not reach the base of contamination as a result of downward trace-element migration. The depths of contamination for these cores are estimated based on their proximity to core 98-BMF-102, and the general trend seen in other cores for the distance to which contamination persists below the silver occurrences, about 30 cm (1 ft.). Core 97-BMF-101-18 was the easternmost core taken, about six meters (20 ft) from the bank of Basin Creek. The thickness of the tailings and contaminated material here was only about 18 cm (0.6 ft.).

Perpendicular traverses, 97-BMF-101A, 101B, and 101C

Traverse A is located near the east end of the main traverse, and intersects the main traverse at core 16 (see figure 2). Figure 4 shows the thickness profile for this traverse. The thicknesses of contamination for cores 97-BMF-101-A2, -A3, and -A4 are estimated, since the cores' maximum penetrations did not reach below the contamination zone. The contamination thicknesses for these cores are also estimated to extend about 30 cm (1 ft.) below the deepest silver occurrences. Figure 4 shows that the tailings and contamination thicknesses are least at the north end of the traverse, near the break in slope to the quartz monzonite hill, greater in the center, and are less again at the south end of the traverse. The thickness at station -A6 is, however, 39 cm (1.3 ft.).

Traverse B is also perpendicular to the main traverse, and intersects the main traverse at core 97-BMF-101-12. The contamination depth profile is shown in figure 5. The first core, 97-BMF-101-B1, was only 19 cm in depth and was clearly tailings material to the bottom, as reflected by a silver content of 180 ppm in the lowest subsample. This core probably reached bedrock at shallow depth, near the break in slope to the north. We have assigned an estimated maximum potential depth of contamination of 30 cm (1 ft.) for this core. The contamination

reaches a moderate thickness of 55 cm (1.8 ft.) at core 97-BMF-101-B4, and then thins again to the south.

Traverse C is towards the western end of the main traverse, and intersects the main traverse at core 97-BMF-101-5. The contamination depth profile is shown in figure 6. Core 97-BMF-101-C5, at the southern end of traverse C, did not penetrate through the bottom of contamination, and the depth shown is estimated, as before, from the general trend seen in other cores.

Estimate of volume of tailings

The areal extent of the flotation mill tailings at the Buckeye mine is estimated at about 13,000 m² (140,000 ft² or about 3.3 acres). Using the values for thickness of contamination for all the cores, a simple contour map of the area can be constructed (figure 7) and the contour interval thicknesses integrated with their areal extent to obtain the total volume affected by contamination. The contamination thicknesses from Table 3 were arranged in increasing order, and assigned to one of five classes, A-E. The classes were assigned thicknesses that represented an approximation of the average for those cores contained in it. Nine cores had thicknesses in the "A" class (25 cm), fifteen in the "B" class (50 cm), four in the "C" class (65 cm), four in the "D" class (80 cm), and three in the "E" class (140 cm). The symbols were then plotted on the site map, and contours developed to estimate areas of similar thickness. For the area beyond the "A" contour, but within the approximate boundary of tailings, a value of 10 cm was used to represent the thickness (area shown marked by "X's"). This designation was for use in estimating volumes, only; the sites marked with "X's" do not represent actual core sites or thickness measurements. In addition, the contours developed are also approximations for use in volume estimates, and are not meant to indicate actual thicknesses. Their positions and values along the four traverses are good estimates, but since the sampling plan is not a true grid, the contour positions far from actual core sites (as in the large area between traverses B and C and south of the main traverse) are necessarily rough approximations. The areal extent of each class is as follows: class X, 5,250 m²; class A, 4,200 m²; class B, 2,600 m²; class C, 700 m²; class D, 410 m²; and class E, 120 m². The sum of the products of the class areas and depths yields a total volume estimate of 3,800 cubic meters, or 5,000 cubic yards. Using an average value for density of the core material of 2.2 g/cm³, a calculation for mass yields an estimate of 8,400 metric tons.

Bed sediments

The analytical data derived from the stream sediments clearly show contribution of trace-elements from the tailings (table 6). The uppermost sample taken, above the Buckeye-Enterprise mine complex and tailings (98-BMS-104), has total-digestion concentrations of the six elements As, Ag, Cd, Cu, Pb, and Zn, at or near the regional uncontaminated geochemical baseline values, with little influence from prospects farther upstream. Sample 97-BMS-101-19, from Basin Creek at the far eastern edge of the tailings, shows slight elevations in concentrations. Sample 97-BMS-101-A7 shows the beginning of influence from the tailings, mostly as increased arsenic and lead concentrations. Samples 97-BMS-101-B7, -C7, and 96-BM-136 all show marked increases in concentrations. Basin Creek probably receives tailings between 97-BMS-101-19 and 97-BMS-101-A7 mostly as material that sloughs off the banks. West of the thick topographic mound centered on 98-BMF-102, the tailings gently slope to the south, and are dissected by surface drainage channels. Sheet flow and surface runoff during storm events or spring snowmelt

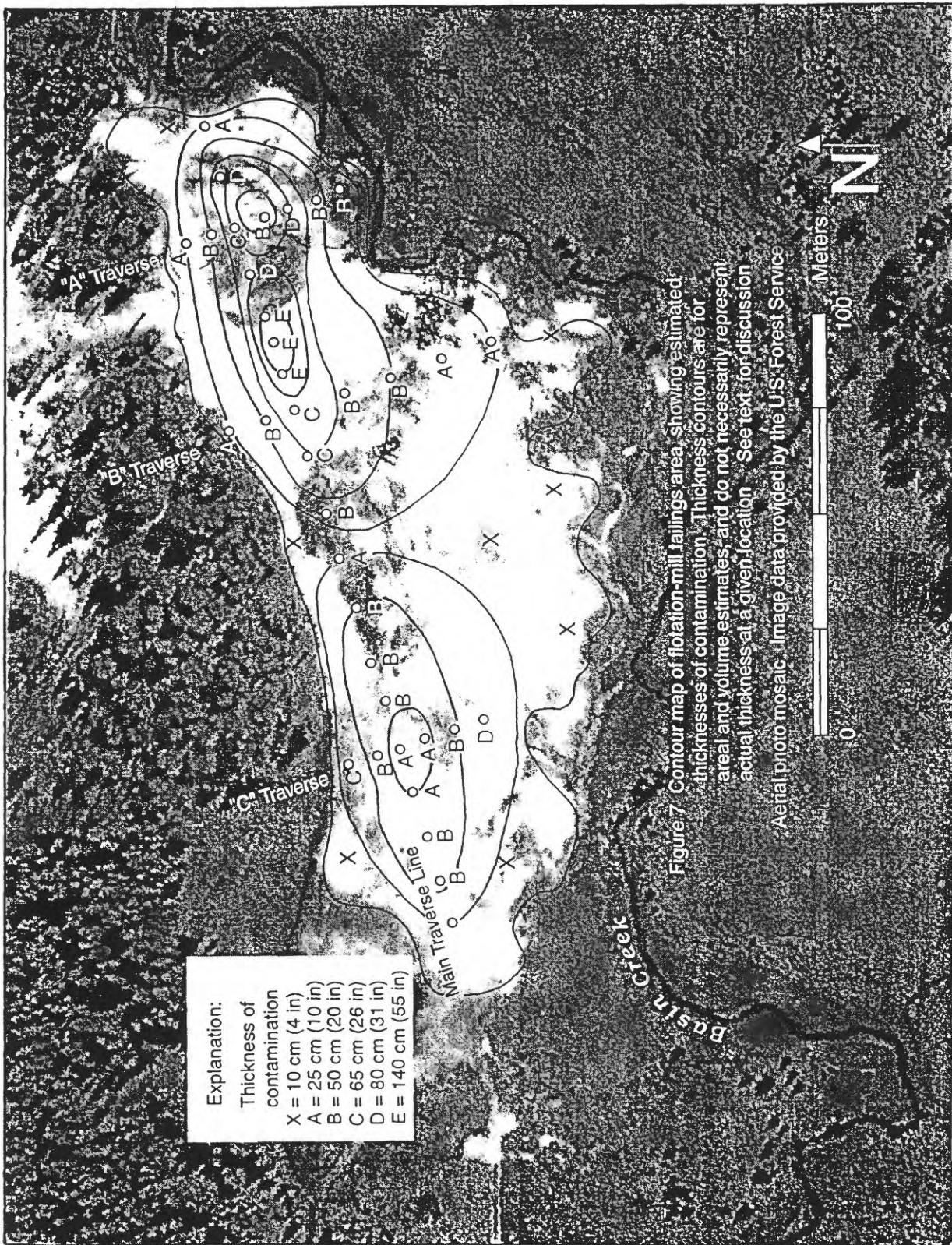


Figure 7 Contour map of flotation-mill tailings area, showing estimated thicknesses of contamination. Thickness contours are for areal and volume estimates, and do not necessarily represent actual thickness at a given location. See text for discussion.

Aerial photo mosaic image data provided by the U.S. Forest Service

probably carry more material to the creek west of traverse B. The concentrations of arseric and lead are significantly higher from 97-BMS-101-B7 downstream to 96-BM-136.

Analyses of trace elements from the warm 2M HCl -1% H₂O₂ leach (table 7) show that much of the trace-element content in the bed sediments is in the leachable phase. This partial extraction releases metals associated with hydrous amorphous iron- and manganese-oxide coatings and colloidal particles incorporated into the bed sediments (Church and others, 1997). The extraction solution only weakly attacks primary sulfide grains with the exception of galena (PbS), which is readily soluble in warm 2M HCl. The ratio of leachable to total concentrations for the metals reveals information about the mineral phases harboring and transporting the different metals in the bed sediments.

Examination of the individual elements from the six bed sediments reveals the following

1. Silver in the leachable phase comprises 40% to 90 % of the total.
2. Arsenic in the leachable phase comprises 45% to 88% of the total arsenic.
3. Cadmium in the leachable phase comprises up to 100% of the total cadmium.
4. Copper in the leachable phase comprises 50% to 90% of the total.
5. Lead in the leachable phase comprises 70% to 100% of the total lead (although since the leach solubilizes primary galena, one cannot differentiate between primary-mineral lead and adsorbed lead).
6. Zinc in the leachable phase comprises 60% to 83% of the total zinc.

The leachability of trace elements, as released by the 2M HCl -1% H₂O₂ leach, from the bed sediments does not directly correspond to the downward mobility of these same elements in the flotation tailings cores. The 2M HCl -1% H₂O₂ solution is more effective in its ability to leach trace elements than the pore waters encountered in the tailings. Evidence of this is reflected by the relative downward immobility of silver and lead in the tailings but high leachability of these two elements when subjected to the 2M HCl -1% H₂O₂ leach. The leachability data of the bed sediments reflect the process of element sorption onto colloids and iron- and manganese-hydroxides, and subsequent settling and incorporation into bed sediments. This process helps describe elemental transport in bed sediments downstream, as discussed in Church and others (1997). The pH of tailings pore waters was as low as 3.5; dissolved oxygen was as low as 4 ppm. Otherwise, the nature of the pore water and its ability to leach, compared to the 2M HCl-1% H₂O₂ leach, was not determined. A pore-water sample from the four-foot-deep trench (core site 98-BMF-102) at a depth of about three and a half feet, in gray, unoxidized tailings contained high concentrations of iron (1,700 mg/L), copper (130 mg/L), zinc (420 mg/L), and arsenic (620 mg/L). The lead concentration was 3,600 µg/L, cadmium was 2,000 µg/L, and silver was low at only 7.5 µg/L. Thus, trace-element downward migration in the tailings pore waters is significant, but the magnitude and processes involved cannot be estimated by or compared with the 2M HCl-1% H₂O₂ leach.

Summary and conclusions

Analytical results for 35 cores collected from flotation tailings from the Buckeye mill tailings site reveal that six environmentally important trace elements (Ag, As, Cd, Cu, Pb and Zn) are present at high concentrations. Contamination from five of the six trace elements (not includ-

ing silver) persists to a depth of about 30 cm (1 ft.) below the tailings, as a result of downward migration into the underlying pre-mining material, mostly quartz monzonite-derived micaceous sand. Calculations based on the contamination depths and areal extent indicate that the total volume of contaminated material (tailings and underlying contaminated sandy material) is about 3,800 m³ (5,000 cubic yards), or about 8,400 metric tons. Analyses of six bed sediments from Basin Creek show significant influence from the mill tailings. The greatest impact on the bed-sediment chemistry occurs downstream of the eastern half of the tailings, where runoff from storms and spring snowmelt enters the creek from surface drainage channels. Partial extractions of the bed sediments reveal that a significant fraction (40% to 100%) of the named trace elements are present in phases solubilized by a warm 2M HCl -1% H₂O₂ leach. These leachable phases include settled colloids and hydrous amorphous iron- and manganese-hydroxide coatings of bed-sediment particles.

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings

Field No.	DEPTH (cm)	sample description
97BMF-101-2-a	9	first 4 inches tan very fine sand to silt, micaceous, no organics
97BMF-101-2-b	20	1/2 inch white leached zone, possibly clay (?), no organics
97BMF-101-2-c	24	tan medium to fine sand, wood fibers
97BMF-101-2-d	36	rusty tan medium to fine sand, iron staining, rootlets, wood fibers
97BMF-101-2-e	57	tan mostly fine sand, some medium sand, light iron-oxidation staining, specks of charcoal, no organics
97BMF-101-3-a	5	light white-gray clay, fibrous, some bits of moss
97BMF-101-3-b	15	dark layer, organics, rootlets
97BMF-101-3-c	29	gray medium to fine sand, micas, slight iron-oxidation, little or no organics
97BMF-101-3-d	40	tan-gray medium to fine sand, section of 1mm sized sand, sulfides, micas, no organics
97BMF-101-3-e	55	tan-gray clay-sized material at top of section, grades into fine sand, abundant mica, iron stains, no organics
97BMF-101-4-a	6	white-gray fine silt, no organics
97BMF-101-4-b	17	red-brown fine sand, micas, iron-oxidation, wood fibers
97BMF-101-4-c	23	red-brown transition zone between organic fibers and medium micaceous sand, no organics
97BMF-101-4-d	34	red-brown medium to fine micaceous sand, quartz, little to no organics
97BMF-101-4-e	55	red-brown fine sand to silt, grades to gray clay, micaceous, no organics
97BMF-101-5-a	5	light gray silt and mud
97BMF-101-5-b	14	dark brown organic layer
97BMF-101-5-c	21	transition zone to sandy tailings below, no organics
97BMF-101-5-d	30	brown silt and clay, mica, some iron-oxidation staining, bits of charcoal
97BMF-101-5-e	51	rusty brown medium sand, mica, iron-oxidation staining, charcoal
97BMF-101-6-a	4	medium gray fine silt, some mica, no sulfides, some wood fibers
97BMF-101-6-b	13	white and gray clay, no organics
97BMF-101-6-c	29	medium-brown fine sand to silt, mica, minor wood fiber
97BMF-101-6-d	47	medium-brown fine sand, silt and clay, iron-oxidation, some wood fiber
97BMF-101-6-e	60	dark brown clay, dark organic material
97BMF-101-7-a	7	tan-gray fine sand, silt, minor organic fiber
97BMF-101-7-b	17	organic layer, fresh mica
97BMF-101-7-c	22	tan and brown transition layer, mixed fine sand, fresh and oxidized mica, some organic fines
97BMF-101-7-d	31	tan blocky silt and clay, fresh and iron oxidized micas, minor iron-oxidation staining, no organics
97BMF-101-7-e	45	brown silt and clay, mica, altered remnant biotite, iron-oxidation, some charcoal
97BMF-101-7-f	59	brown waxy clay, very fine mica, dark organic material

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101-8-a	6	tan-gray silt and clay, some medium sand, no organics
97BMF-101-8-b	19	dark gray silt, minor iron staining, some charcoal
97BMF-101-8-c	29	light gray mud and silt, micas, some iron staining, wood fiber transition zone
97BMF-101-8-d	34	dark gray waxy clay, some fine sand, iron staining, some organics
97BMF-101-8-e	45	medium gray sand and clay, micaceous, moderate iron staining, some charcoal
97BMF-101-8-f	60	gray fine sand to silt, micaceous, moderate iron staining, no organics
97BMF-101-9-a	6	medium gray blocky silt and mud, fresh mica, charcoal
97BMF-101-9-b	19	lighter gray-brown medium to fine sand, silt, fresh micas, charcoal
97BMF-101-9-c	27	gray transition zone, charcoal, fresh micas
97BMF-101-9-d	44	light tan-gray silt, coarse to fine sand, fresh mica, some wood fibers
97BMF-101-10-a	3	brown well-sorted fine sand to silt, no sulfides, minor mica, no organics
97BMF-101-10-b	13	dark brown well-sorted fine sand to silt, no organics
97BMF-101-10-c	27	tan-brown fine sand to silt, slightly oxidized micas, some wood fibers
97BMF-101-10-d	42	medium-brown silt, medium to fine sand, micaceous, smaller micas are slightly oxidized, no organics
97BMF-101-10-e	57	rusty-brown silt, coarse to fine sand, a few pebbles to 1/4 inch
97BMF-101-11-a	6	brown and white silt, medium to fine sand, in white clay matrix, no organics
97BMF-101-11-b	19	dark brown clay and silt, moderate iron-oxidation, some wood fibers, rootlets
97BMF-101-11-c	26	white leached-clay transition zone, some micas, no organics
97BMF-101-11-d	31	brown and light-orange silt, fine sand, micaceous, root fibers
97BMF-101-11-e	39	tan fine sand, micaceous, strong iron-oxidation staining, no organics
97BMF-101-11-f	50	tan-gray blocky clay and silt, some mica, iron-oxidation, some wood fibers
97BMF-101-11-g	61	dark brown dense, waxy material, organic material
97BMF-101-12-a	5	tan fine sand, minor white clay, few 3mm pebbles, wood bits
97BMF-101-12-b	12	brown silt, some wood fibers
97BMF-101-12-c	21	dark brown silt, little mica, little iron-oxidation, root fibers
97BMF-101-12-d	32	dark brown blocky clay, some mica, iron-oxidation, root fibers
97BMF-101-12-e	49	tan coarse, medium, and fine sand, micaceous, fine sand at bottom of the section, iron-oxidation, no organics
97BMF-101-12-f	63	tan silt, iron-oxidation, micaceous, from bottom of the core

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101-13-a	4	light gray silt-sized tailings, fine quartz sand, no organics
97BMF-101-13-b	12	light gray silt-sized tailings, fine quartz sand, some light buff fine sand, some micas, no organics
97BMF-101-13-c	20	gray and dark gray silty sulfidic tailings, no organics
97BMF-101-13-d	34	gray and yellow fine-grained sand, fine quartz sand, no organics
97BMF-101-13-e	52	dark gray and yellow fine sand, fine quartz sand, some very fine material, no organics
97BMF-101-13-f	61	chocolate-brown and gray very fine tailings, fibrous peaty plug at bottom
97BMF-101-13-g	63	yellow streaked, fibrous peaty plug
97BMF-101-14-a	12	light gray-brown with a hint of yellow medium-to-fine sand, quartz sand, sulfur odor, no mica, no sulfides, no organics
97BMF-101-14-b	28	light gray-brown and yellow fine sand, quartz sand, no organics
97BMF-101-14-c	38	yellow silt, some white clay, no sulfides, no organics
97BMF-101-14-d	52	light gray with a hint of yellow fine sand, dark granules, fresh sulfides, no organics
97BMF-101-15-a	11	brown medium-to-fine sand, mixed with some coarse sand, 1/4" clasts, smells of sulfur, possible biotite, possibly a few fresh sulfides, no organics
97BMF-101-15-b	25	brown well-sorted silt, some leached white, some wood fibers
97BMF-101-15-c	36	chocolate-brown silt, minor oxidized mica, wood fiber
97BMF-101-15-d	46	brown silt, oxidized mica, little or no wood
97BMF-101-15-e	53	dark organics, black clay, oxidized mica
97BMF-101-15-f	61	brown medium-to-fine sand, micaceous, no organics
97BMF-101-15-g	64	brown, organic material
97BMF-101-16-a	12	medium-brown clay and silt, micaceous, minor root fiber
97BMF-101-16-b	31	medium-brown and gray silt, fine sand, some charcoal
97BMF-101-16-c	40	medium-brown, tan and yellow clay and silt, micaceous, sulfurous, no organics
97BMF-101-16-d	56	gray-brown fine silt, less clay cement, micaceous, bits of charcoal, root fiber, iron-oxidation, trace yellow
97BMF-101-17-a	6	medium-brown silt, micaceous, some charcoal
97BMF-101-17-b	17	dark brown silt, micaceous, some charcoal
97BMF-101-17-c	30	dark gray silt, micaceous, some charcoal
97BMF-101-17-d	44	medium-brown medium to fine sand, minor coarse sand, micaceous, no organics
97BMF-101-17-e	58	medium-brown, coarse to fine sand, micaceous, some charcoal, wood fiber

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101-18-a	5	medium-brown silt, micaceous, some wood fiber
97BMF-101-18-b	16	medium-brown silt, micaceous, iron-oxidation staining, no organics
97BMF-101-18-c	28	light brown silt, micaceous, strong iron-oxidation staining, no organics
97BMF-101-18-d	39	light brown well-sorted silt and fine sand, micaceous, charcoal
97BMF-101-18-e	47	light brown fine sand to silt, no charcoal, some clay blockiness, no wood
97BMF-101-18-f	59	light brown blocky, clay, tough, waxy, strong iron-oxidation
97BMF-101A1-a	2	tan fine sand, quartz, not micaceous, no organics
97BMF-101A1-b	10	dark tan silt, coarse to fine sand, some mica, charcoal
97BMF-101A1-c	23	tan and orange silt, blocky, minor medium coarse sand, much iron-oxidation, oxidized micas, no organics
97BMF-101A1-d	40	dark brown blocky silt, fresh slightly oxidized micas, no organics
97BMF-101A2-a	6	tan and brown fine sand, a few larger clasts, a few wood bits
97BMF-101A2-b	12	white clay, fine sand, leached, no organics
97BMF-101A2-c	23	tan-gray silt and clay, sulfides, micas, organics
97BMF-101A2-d	35	dark brown clay and silt, some oxidized micas, no organics
97BMF-101A2-e	46	medium tan-gray silt and clay, fair charcoal, much oxidized micas, some organics
97BMF-101A2-f	58	tan silt, no clay, no charcoal, minor wood fiber, some oxidized micas
97BMF-101A2-g	63	tan, tough waxy dark plug, clay, organic, moderate iron-oxidation stains, few oxidized micas
97BMF-101A3-a	7	medium-brown silt, minor clay, some oxidized micas, a few 2-3 mm grains, no organics
97BMF-101A3-b	21	medium-brown, silt, minor clay, oxidized micas, a few 2-3 mm grains, no organics
97BMF-101A3-c	31	tan blocky silt and clay, oxidized micas, no organics
97BMF-101A3-d	36	brown and orange loose fine sand, abundant oxidized micas to 1 mm, some charcoal
97BMF-101A3-e	42	medium-brown and orange, blocky clay and silt, much oxidized micas, some iron-oxidation stains, root fiber
97BMF-101A3-f	56	brown and orange medium sand to silt, much iron-oxidation stains, lot oxidized micas, minor charcoal
97BMF-101A4-a	6	medium-brown silt, some coarse sand, oxidized micas, no organics
97BMF-101A4-b	16	medium-brown silt, some coarse sand, oxidized micas, no organics
97BMF-101A4-c	26	medium-brown coarse sand to silt, oxidized micas, smells sulfurous, no organics
97BMF-101A4-d	38	brown, silt, and medium sand, oxidized micas, minor sulfur smell, no organics
97BMF-101A4-e	45	brown and orange well-sorted silt, little or no coarse sand, iron-oxidation, oxidized micas, little or no clay, no organics
97BMF-101A4-f	53	dark tan-gray well-sorted silt, some charcoal, abundant oxidized mica, no organics
97BMF-101A4-g	62	dark tan-gray well-sorted silt, some charcoal, abundant oxidized mica, no organics, some iron-oxidation

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101A5-a	8	medium-brown silt, oxidized micas, minor coarse sand, no organics
97BMF-101A5-b	19	medium-brown silt, oxidized micas, minor coarse sand, no organics, slight iron-oxidation
97BMF-101A5-c	28	medium-brown silt, oxidized micas, minor coarse sand, no organics, moderate iron-oxidation
97BMF-101A5-d	39	rusty brown medium to fine sand, oxidized micas, strong iron-oxidation colors, no organics
97BMF-101A5-e	45	tan and orange fine silt, medium sand, abundant oxidized micas, iron-oxidation, some wood fiber
97BMF-101A5-f	52	tan and orange coarse, medium and fine sand, charcoal, iron-oxidation, oxidized micas
97BMF-101A6-a	5	medium-tan silt, one 1/2" rock, a few coarse pebbles, some oxidized micas, minor iron-oxidation, no organics
97BMF-101A6-b	12	gray blocky silt, few micas, some root fibers
97BMF-101A6-c	23	tan-gray slightly blocky silt, minor clay, root fibers, some oxidized micas, very little iron-oxidation
97BMF-101A6-d	38	gray silt, medium to fine sand, oxidized micas, iron-oxidation, no organics
97BMF-101A6-e	47	gray silt, oxidized micas, minor charcoal, sulfur odor, no organics
97BMF-101A6-f	52	tan silt, medium sand, oxidized micas, minor wood fiber
97BMF-101A6-g	56	gray clay, some rootlets, contacts silty tails below
97BMF-101B1-a	5	yellow-gray fine sand, sulfurous smell, no organics
97BMF-101B1-b	13	yellow-gray medium to fine sand, sulfurous smell, no organics
97BMF-101B1-c	19	brown and yellow medium-to-fine sand, sulfur odor, no organics
97BMF-101B2-a	3	yellow-gray medium and fine sand, sulfurous odor, no organics
97BMF-101B2-b	14	yellow-gray medium and fine sand, sulfurous odor, no organics
97BMF-101B2-c	28	dark brown silt, peaty wood fibers
97BMF-101B2-d	43	dark gray silt and clay, iron-oxidation stains, minor charcoal, oxidized micas
97BMF-101B2-e	59	gray-brown clay and silt, medium sand, some oxidized micas, no organics
97BMF-101B4-a	3	medium-brown silt, some white leached clay, fine micas, no organics
97BMF-101B4-b	17	medium-brown silt, fine micas, no organics
97BMF-101B4-c	31	tan-brown silt, medium sand, micaceous, some wood fiber
97BMF-101B4-d	38	medium-brown silt, micaceous, some organics
97BMF-101B4-e	44	brown, slightly waxy clay, iron mottled, very fine micas, no organics
97BMF-101B4-f	47	tan-orange well-sorted silt, iron-oxidation, oxidized micas to 1mm, no organics
97BMF-101B4-g	55	tan coarse to fine sand, iron-oxidation, micas, no organics
97BMF-101B4-h	64	tan medium to fine sand, iron-oxidation, micas, no organics

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101B5-a	5	light brown medium to fine sand, no mica, no organics
97BMF-101B5-b	17	medium-brown homogenous silt, minor white leached material, no organics
97BMF-101B5-c	27	dark brown silt, moderate oxidized micas, orange from iron-oxidation, no organics
97BMF-101B5-d	45	orange-yellow fine homogenous silt, very strong iron-oxidation, micas, no organics
97BMF-101B5-e	62	orange-yellow homogenous silt, minor blocky, very strong iron-oxidation, micas, minor charcoal
97BMF-101B6-a	3	medium-brown blocky homogeneous fine silt, some oxidized micas, no organics
97BMF-101B6-b	15	tan-brown blocky silt, a few 3 mm clasts, micaceous, some iron-oxidation, no organics
97BMF-101B6-c	25	tan coarse to fine sand, loose, micaceous, some iron-oxidation, no organics
97BMF-101B6-d	34	transition zone between c and e
97BMF-101B6-e	45	orange-yellow coarse to fine sand, strong iron-oxidation, some mafic specks, oxidized micas, no organics
97BMF-101B6-f	55	tan silt, charcoal, micaceous, moderate iron-oxidation
97BMF-101B6-g	64	tan-orange medium to fine sand, strong iron-oxidation, oxidized micas, some charcoals
97BMF-101B7-a	3	brown-buff silt, no organics
97BMF-101B7-b	8	white leached buff silt, no organics
97BMF-101B7-c	14	brown and orange silt, iron-oxidation, minor root fiber
97BMF-101B7-d	22	medium-brown and orange blocky silt, some root fibers, some iron-oxidation, fine micas
97BMF-101B7-e	33	gray and orange silt, strong iron-oxidation, some root fiber
97BMF-101B7-f	52	gray-brown and orange silt, moderate to strong iron-oxidation, no organics
97BMF-101C1-a	8	white and tan clay and silt, moist, leached, no organics
97BMF-101C1-b	17	dark brown silt, peaty organic plug, fibrous
97BMF-101C1-c	21	dark brown organic iron-rich plug, maybe some clay
97BMF-101C1-d	28	light tan clay and silt, moist, small amount of organics
97BMF-101C1-e	37	dark brown clay, minor Fe streaking, moist, organics
97BMF-101C1-f	51	brown coarse to fine sand, micaceous, light iron-oxidation, some root fibers
97BMF-101C1-g	64	brown coarse to fine sand, micaceous, light iron-oxidation, some root fibers

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
97BMF-101C2-a	3	tan-brown clay and silt, moist, no organics
97BMF-101C2-b	9	white leached clay, no organics
97BMF-101C2-c	15	dark brown peaty silt, moist, organics
97BMF-101C2-d	22	tan-brown clay and silt, slightly moist, no organics
97BMF-101C2-e	28	tan medium to fine sand, some micas, no organics
97BMF-101C2-f	34	tan blocky silt and clay, micas, no organics
97BMF-101C2-g	40	tan waxy dense organic clay
97BMF-101C2-h	45	tan-gray silt, coarse to medium sand, some oxidized micas, no organics
97BMF-101C2-i	53	tan-gray silt, coarse to medium sand, some oxidized micas, no organics
97BMF-101C2-j	62	gray silt, medium to fine sand, micas, no organics
97BMF-101C3-a	4	light-tan silt and clay, possibly leached, no organics
97BMF-101C3-b	15	chocolate-brown blocky silt, minor medium sand, no organics
97BMF-101C3-c	26	gray blocky clay, some iron-oxidation staining, no organics
97BMF-101C3-d	33	tan-gray blocky silt, some medium sand, micaceous, some iron-oxidation, no organics
97BMF-101C3-e	43	gray silt, fine sand, micaceous, some iron-oxidation, no organics
97BMF-101C3-f	58	gray silt, medium to very fine sand, micaceous, iron-oxidation, no organics
97BMF-101C4-a	6	buff-gray silt and clay, few micas, no organics
97BMF-101C4-b	18	light chocolate-brown fine sand to silt, some mica, moderate iron-oxidation stains, no organics
97BMF-101C4-c	31	gray-brown and orange silt, oxidized micas, moderately strong iron-oxidation, no organics
97BMF-101C4-d	47	medium-brown and orange medium to fine sand, many oxidized micas, iron-oxidation, no organics
97BMF-101C4-e	61	brown medium loose sand, micaceous, both oxidized and fresh biotite, iron-oxidation staining, a few wood fibers
97BMF-101C5-a	5	buff medium to fine sand, micas, organics present
97BMF-101C5-b	14	rusty brown medium and fine sand, minor clay, a few 3 mm pebbles, no organics
97BMF-101C5-c	21	yellow silt and clay, medium to fine sand, a few 2 mm pebbles, yellow sulfate, no organics
97BMF-101C5-d	30	yellow and orange silt and clay, a few organic fibers
97BMF-101C5-e	42	orange and brown coarse to medium sand, oxidized micas, unoxidized biotite in pebbles, strong iron-oxidation, no organics

Table 4 Field Numbers, depths to midpoints of intervals, and interval sample descriptions for cores from Buckeye flotation tailings (cont.)

FieldNo	DEPTH (cm)	sample description
98BMF 102A1-a	0	brown fine sand to silt, top one inch contains wood bits, needles and grass
98BMF 102A1-b	10	tan-brown fine sand to silt, contains a few rootlets or grass blades, mica and sulfur odor
98BMF 102A1-c	19	tan-brown fine sand to silt, some oxidized material, micas, no organics
98BMF 102A1-d	28	tan silt, medium sand, some mica, oxidized materials, a few twigs and pine needles
98BMF 102A1-e	36	tan silt, medium sand, some mica, oxidized material, a few twigs or pine needles
98BMF 102A2-f	47	tan-brown medium sand to silt, micas, some oxidized, no organics
98BMF 102A2-g	59	tan-brown coarse sand to silt, some pebble sized clasts, mica, no organics
98BMF 102A2-h	72	rusty-brown coarse sand to silt, mica, bottom one inch rusty-brown packed fine sand to silt, no organics

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana

Field Number	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101-2-a	9	7.1	1.2	5.2	2.1	1.1	0.06	0.49	340	20	
97BMF-101-2-b	20	8.0	0.01	2.9	3.3	0.28	0.05	0.03	0.10	270	220
97BMF-101-2-c	24	7.2	1.5	2.3	2.8	0.70	1.5	0.06	0.36	220	5
97BMF-101-2-d	36	6.8	1.4	2.2	3.1	0.55	1.5	0.05	0.27	180	<2
97BMF-101-2-e	57	7.5	1.4	3.1	2.7	0.86	1.4	0.08	0.39	270	<2
97BMF-101-3-a	5	6.9	0.22	4.2	2.6	0.31	0.25	0.04	0.19	170	76
97BMF-101-3-b	15	7.1	0.53	2.2	1.2	0.47	0.56	0.19	0.30	120	5
97BMF-101-3-c	29	7.0	1.3	2.0	2.9	0.57	1.3	0.05	0.28	210	<2
97BMF-101-3-d	40	8.0	1.5	3.2	2.5	0.83	1.5	0.06	0.38	410	<2
97BMF-101-3-e	55	8.5	1.4	3.2	1.9	1.0	1.3	0.06	0.52	400	<2
97BMF-101-4-a	6	8.2	0.09	3.7	3.2	0.31	0.12	0.06	0.16	180	56
97BMF-101-4-b	17	7.4	1.2	3.5	1.9	0.95	1.1	0.09	0.46	260	<2
97BMF-101-4-c	23	6.7	1.2	2.4	2.7	0.68	1.3	0.06	0.32	210	<2
97BMF-101-4-d	34	6.2	1.1	1.8	3.1	0.43	1.3	0.04	0.21	140	<2
97BMF-101-4-e	55	8.1	1.2	2.6	2.3	0.75	1.2	0.05	0.39	230	<2
97BMF-101-5-a	5	5.3	0.23	3.6	1.7	0.26	0.27	0.08	0.18	150	84
97BMF-101-5-b	14	7.0	0.56	2.3	1.3	0.40	0.61	0.14	0.27	120	6
97BMF-101-5-c	21	7.9	1.1	2.0	2.1	0.60	1.1	0.06	0.33	180	<2
97BMF-101-5-d	30	8.2	1.1	3.0	2.1	0.84	1.2	0.05	0.41	250	<2
97BMF-101-5-e	51	6.9	1.3	1.5	3.3	0.47	1.4	0.03	0.23	160	<2
97BMF-101-6-a	4	4.3	0.20	2.3	1.6	0.19	0.25	0.04	0.14	130	59
97BMF-101-6-b	13	6.9	0.05	3.5	2.8	0.25	0.10	0.03	0.12	240	130
97BMF-101-6-c	29	5.4	0.56	1.9	1.1	0.36	0.59	0.11	0.25	110	7
97BMF-101-6-d	47	8.5	1.0	2.8	1.7	0.70	1.0	0.03	0.43	210	<2
97BMF-101-6-e	60	9.6	0.73	3.4	1.3	0.69	0.76	0.01	0.47	190	<2
97BMF-101-7-a	7	4.2	0.21	2.6	1.6	0.18	0.27	0.06	0.14	120	51
97BMF-101-7-b	17	5.7	0.64	2.1	1.4	0.31	0.70	0.16	0.26	100	7
97BMF-101-7-c	22	7.6	1.1	1.5	2.3	0.40	1.2	0.05	0.32	130	2
97BMF-101-7-d	31	8.7	1.0	2.6	1.9	0.81	1.0	0.05	0.47	260	2
97BMF-101-7-e	45	8.8	0.96	3.0	1.8	0.73	0.99	0.01	0.45	220	<2
97BMF-101-7-f	59	9.2	0.58	3.7	1.1	0.60	0.62	0.02	0.42	160	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mn ppm
97BMF-101-2-a	9400	460	54	60	8	15	250	12	29	30	4
97BMF-101-2-b	13000	670	85	48	<2	61	16	45	19	19	22
97BMF-101-2-c	3100	590	17	45	5	53	12	24	18	<2	<2
97BMF-101-2-d	1300	800	6	48	4	<2	30	11	26	17	<2
97BMF-101-2-e	350	660	<2	59	7	4	67	17	29	26	<2
97BMF-101-3-a	19000	380	110	39	<2	4	300	13	26	19	14
97BMF-101-3-b	1800	440	11	58	3	24	500	15	30	36	<2
97BMF-101-3-c	350	770	<2	45	4	<2	36	11	24	22	<2
97BMF-101-3-d	260	750	<2	53	7	16	50	15	27	30	<2
97BMF-101-3-e	37	580	<2	71	9	10	110	16	36	44	<2
97BMF-101-4-a	18000	430	110	39	<2	4	240	17	28	18	14
97BMF-101-4-b	2100	550	10	52	6	6	130	15	27	30	<2
97BMF-101-4-c	270	680	<2	39	4	3	57	12	20	21	<2
97BMF-101-4-d	24	790	<2	37	3	<2	26	7	20	16	<2
97BMF-101-4-e	12	680	<2	78	5	4	59	13	44	33	<2
97BMF-101-5-a	23000	370	140	34	<2	9	280	8	26	19	10
97BMF-101-5-b	5500	510	32	62	2	24	420	14	30	29	<2
97BMF-101-5-c	720	650	3	60	3	10	130	13	30	32	<2
97BMF-101-5-d	660	670	3	62	6	13	180	17	31	40	<2
97BMF-101-5-e	250	930	<2	41	3	<2	31	10	21	20	<2
97BMF-101-6-a	13000	330	77	31	<2	3	130	8	22	18	6
97BMF-101-6-b	20000	620	130	22	<2	3	170	12	29	18	18
97BMF-101-6-c	3500	430	21	33	<2	11	190	10	17	23	3
97BMF-101-6-d	1400	610	8	72	5	20	220	17	38	45	<2
97BMF-101-6-e	600	590	6	110	5	18	230	15	59	55	<2
97BMF-101-7-a	17000	340	95	27	<2	3	10	6	19	17	6
97BMF-101-7-b	7000	480	38	30	<2	9	260	13	16	20	2
97BMF-101-7-c	1700	700	9	44	<2	6	140	13	24	24	<2
97BMF-101-7-d	2400	620	13	61	5	12	230	13	29	43	<2
97BMF-101-7-e	700	620	4	70	5	16	160	17	36	42	<2
97BMF-101-7-f	420	510	5	110	5	17	180	15	64	53	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Pb ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm
97BMF-101-2-a	< 4	25	12	3000	15	220	23	88
97BMF-101-2-b	< 4	30	< 3	46000	8	73	12	39
97BMF-101-2-c	7	19	6	770	9	300	12	55
97BMF-101-2-d	5	18	5	150	7	320	13	52
97BMF-101-2-e	10	28	9	120	12	300	18	84
97BMF-101-3-a	< 4	20	< 3	12000	8	93	17	44
97BMF-101-3-b	9	29	7	510	16	120	26	77
97BMF-101-3-c	9	18	5	61	7	300	12	56
97BMF-101-3-d	8	23	8	76	10	310	16	89
97BMF-101-3-e	14	32	11	110	14	240	28	120
97BMF-101-4-a	< 4	19	< 3	13000	9	120	22	45
97BMF-101-4-b	6	24	10	210	12	220	16	110
97BMF-101-4-c	9	18	6	65	7	280	10	67
97BMF-101-4-d	8	15	4	63	5	290	9	44
97BMF-101-4-e	10	38	9	100	13	250	9	44
97BMF-101-5-a	< 4	18	< 3	16000	7	100	15	32
97BMF-101-5-b	9	36	7	630	21	140	27	67
97BMF-101-5-c	7	28	7	120	15	230	26	89
97BMF-101-5-d	9	30	10	100	15	240	32	120
97BMF-101-5-e	10	16	4	65	6	320	12	41
97BMF-101-6-a	< 4	14	< 3	11000	5	87	9	25
97BMF-101-6-b	< 4	16	< 3	33000	6	110	14	33
97BMF-101-6-c	< 4	15	5	310	12	130	18	57
97BMF-101-6-d	10	38	10	220	14	210	26	140
97BMF-101-6-e	9	58	12	150	20	160	34	150
97BMF-101-7-a	< 4	12	< 3	9700	5	85	9	23
97BMF-101-7-b	6	14	4	680	14	160	21	44
97BMF-101-7-c	10	17	4	110	11	260	16	63
97BMF-101-7-d	14	31	9	120	15	210	27	130
97BMF-101-7-e	10	36	10	130	15	200	27	110
97BMF-101-7-f	8	62	12	120	20	130	33	130

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101-8-a	6	4.9	0.18	2.2	1.7	0.21	0.05	0.15	0.140	35	
97BMF-101-8-b	19	8.2	0.53	2.1	0.93	0.53	0.42	0.15	0.32	120	<2
97BMF-101-8-c	29	9.5	1.2	3.5	1.4	1.0	0.85	0.06	0.53	280	<2
97BMF-101-8-d	34	9.6	0.93	3.3	1.8	0.82	0.75	0.02	0.45	220	<2
97BMF-101-8-e	45	8.8	1.0	2.8	2.1	0.75	0.93	0.03	0.40	200	<2
97BMF-101-8-f	60	8.6	1.2	2.6	2.1	0.72	1.0	0.02	0.43	220	<2
97BMF-101-9-a	6	8.1	0.70	2.0	1.6	0.59	0.71	0.10	0.35	160	11
97BMF-101-9-b	19	9.5	0.97	2.4	2.0	0.90	0.96	0.05	0.47	240	<2
97BMF-101-9-c	27	8.1	1.3	1.3	3.0	0.46	1.5	0.03	0.28	160	<2
97BMF-101-9-d	44	6.7	1.5	0.83	3.2	0.34	1.6	0.03	0.20	140	<2
97BMF-101-10-a	3	5.4	0.53	2.1	2.0	0.28	0.65	0.09	0.27	140	38
97BMF-101-10-b	13	7.0	0.78	2.4	1.7	0.45	0.87	0.13	0.37	140	4
97BMF-101-10-c	27	7.4	1.1	2.3	2.8	0.54	1.3	0.07	0.33	230	<2
97BMF-101-10-d	42	7.2	1.4	1.4	3.0	0.47	1.4	0.03	0.28	180	<2
97BMF-101-10-e	57	7.0	1.5	1.2	3.3	0.41	1.5	0.03	0.33	240	<2
97BMF-101-11-a	6	4.8	0.22	1.9	1.5	0.22	0.28	0.08	0.16	150	44
97BMF-101-11-b	19	8.0	0.51	2.7	0.98	0.54	0.49	0.13	0.32	150	2
97BMF-101-11-c	26	8.9	0.66	3.3	1.1	0.78	0.59	0.07	0.45	220	<2
97BMF-101-11-d	31	8.4	1.6	3.0	2.1	0.97	1.3	0.03	0.52	540	2
97BMF-101-11-e	39	7.3	1.6	3.0	2.7	0.79	1.4	0.03	0.43	410	<2
97BMF-101-11-f	50	8.6	1.2	3.0	1.6	0.74	1.0	0.02	0.46	850	<2
97BMF-101-11-g	61	10	0.81	3.1	1.3	0.63	0.60	0.02	0.44	230	<2
97BMF-101-12-a	5	3.5	0.19	2.0	1.6	0.13	0.29	0.02	0.12	120	60
97BMF-101-12-b	12	5.1	0.39	3.7	0.79	0.33	0.43	0.16	0.28	110	6
97BMF-101-12-c	21	7.8	0.63	4.3	1.1	0.68	0.64	0.11	0.42	190	<2
97BMF-101-12-d	32	8.4	0.75	5.0	1.3	0.77	0.78	0.05	0.51	220	2
97BMF-101-12-e	49	7.2	1.4	2.1	2.9	0.54	1.5	0.04	0.31	210	<2
97BMF-101-12-f	63	7.9	1.5	4.2	2.0	0.90	1.4	0.05	0.52	350	<2

Table 6 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm	Mo ppm
97BMF-101-8-a	13000	380	79	28	<2	6	110	9	19	20	7	
97BMF-101-8-b	520	460	7	81	4	29	96	16	44	44	<2	
97BMF-101-8-c	220	570	5	110	7	22	46	19	68	59	<2	
97BMF-101-8-d	180	620	4	110	6	23	190	17	70	50	<2	
97BMF-101-8-e	150	680	<2	94	5	16	140	16	59	41	<2	
97BMF-101-8-f	420	650	<2	85	5	10	160	17	51	43	<2	
97BMF-101-9-a	3000	500	17	54	3	16	210	17	29	37	2	
97BMF-101-9-b	590	610	3	83	6	27	220	20	49	52	<2	
97BMF-101-9-c	220	880	<2	81	3	<2	95	14	47	28	<2	
97BMF-101-9-d	150	830	<2	51	<2	<2	23	11	29	17	<2	
97BMF-101-10-a	12000	550	61	29	<2	5	220	12	20	20	9	
97BMF-101-10-b	5000	570	27	35	<2	12	180	23	18	28	<2	
97BMF-101-10-c	4100	750	21	44	3	7	110	12	23	28	<2	
97BMF-101-10-d	850	810	4	48	3	<2	65	13	25	24	<2	
97BMF-101-10-e	400	940	<2	91	2	<2	33	10	54	16	<2	
97BMF-101-11-a	11000	380	60	40	<2	10	140	10	25	19	4	
97BMF-101-11-b	4700	450	28	78	3	11	160	15	43	41	<2	
97BMF-101-11-c	540	470	6	90	5	23	70	18	52	47	<2	
97BMF-101-11-d	99	630	7	99	8	14	100	16	55	37	<2	
97BMF-101-11-e	46	640	3	82	7	2	100	11	47	24	<2	
97BMF-101-11-f	66	620	10	96	8	17	260	17	55	52	<2	
97BMF-101-11-g	91	590	13	120	5	7	390	22	71	57	<2	
97BMF-101-12-a	10000	350	57	28	<2	<2	60	7	19	16	5	
97BMF-101-12-b	23000	310	120	27	<2	17	240	11	14	25	<2	
97BMF-101-12-c	5700	420	31	42	4	21	220	15	20	45	<2	
97BMF-101-12-d	3900	440	19	44	6	17	190	17	22	63	<2	
97BMF-101-12-e	990	770	4	48	3	3	33	12	26	22	<2	
97BMF-101-12-f	1800	680	8	82	8	7	83	17	43	38	<2	

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101-8-a	<4	14	<3	11000	6	67	11	32	5	<1	380
97BMF-101-8-b	10	49	13	180	21	110	25	97	38	4	350
97BMF-101-8-c	8	57	15	120	21	190	33	160	49	4	540
97BMF-101-8-d	10	61	14	160	19	180	35	150	55	5	410
97BMF-101-8-e	11	52	11	120	16	220	31	110	43	4	240
97BMF-101-8-f	9	49	11	300	16	220	29	100	37	4	250
97BMF-101-9-a	<4	28	8	1700	17	150	27	80	16	2	250
97BMF-101-9-b	10	41	12	110	17	200	32	98	29	3	250
97BMF-101-9-c	8	31	5	93	9	330	20	59	18	2	130
97BMF-101-9-d	7	19	<3	75	5	350	9	25	10	1	67
97BMF-101-10-a	<4	13	<3	10000	9	140	19	39	6	<1	270
97BMF-101-10-b	8	15	6	720	12	180	21	63	8	1	130
97BMF-101-10-c	7	19	5	120	8	280	16	78	9	1	110
97BMF-101-10-d	7	18	4	66	8	310	13	56	9	1	110
97BMF-101-10-e	11	28	<3	55	6	350	13	42	11	2	68
97BMF-101-11-a	4	19	<3	6500	7	78	12	33	9	1	250
97BMF-101-11-b	7	48	11	280	17	110	23	94	32	4	310
97BMF-101-11-c	8	50	13	110	21	130	30	150	40	4	550
97BMF-101-11-d	9	51	11	160	14	290	25	120	35	4	610
97BMF-101-11-e	6	39	8	120	9	310	14	92	25	3	380
97BMF-101-11-f	6	52	13	150	17	220	32	110	41	4	710
97BMF-101-11-g	10	68	17	190	24	170	40	150	64	6	960
97BMF-101-12-a	<4	12	<3	9700	3	91	7	20	3	<1	560
97BMF-101-12-b	<4	13	6	1100	11	81	17	51	7	1	160
97BMF-101-12-c	5	19	10	140	14	120	24	110	10	1	260
97BMF-101-12-d	<4	21	12	310	15	130	31	180	11	1	310
97BMF-101-12-e	6	22	5	130	8	320	13	50	11	1	130
97BMF-101-12-f	6	43	11	150	14	290	27	100	26	3	290

Table 6 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101-13-a	4	2.9	0.006	0.73	1.3	0.09	0.02	< 0.005	0.09	85	57
97BMF-101-13-b	12	3.3	< 0.005	2.2	1.5	0.12	< 0.005	< 0.005	0.07	140	200
97BMF-101-13-c	20	4.0	< 0.005	8.0	1.8	0.14	< 0.005	< 0.005	0.06	160	290
97BMF-101-13-d	34	1.9	< 0.005	4.0	0.88	0.06	< 0.005	< 0.005	0.06	88	120
97BMF-101-13-e	52	4.0	0.02	4.7	1.9	0.12	0.006	< 0.005	0.10	130	70
97BMF-101-13-f	61	8.0	0.007	5.6	3.4	0.24	0.04	< 0.005	0.13	240	210
97BMF-101-13-g	65	5.9	0.22	2.8	1.9	0.28	0.19	0.19	0.21	250	77
97BMF-101-14-a	12	2.4	< 0.005	0.92	1.0	0.08	0.009	< 0.005	0.09	88	120
97BMF-101-14-b	28	2.6	< 0.005	5.2	1.2	0.08	< 0.005	0.009	0.06	110	270
97BMF-101-14-c	38	5.5	< 0.005	3.4	2.2	0.18	< 0.005	0.007	0.07	180	96
97BMF-101-14-d	52	1.6	< 0.005	0.48	0.71	0.06	< 0.005	< 0.005	0.06	67	44
97BMF-101-15-a	11	5.6	0.65	2.9	2.2	0.26	0.93	0.03	0.20	220	38
97BMF-101-15-b	25	4.3	0.17	3.9	1.6	0.18	0.25	0.04	0.15	140	71
97BMF-101-15-c	36	6.7	0.61	2.9	1.2	0.46	0.65	0.20	0.36	140	4
97BMF-101-15-d	46	8.1	1.2	1.8	2.5	0.67	1.2	0.12	0.32	220	<2
97BMF-101-15-e	53	9.7	0.61	3.2	1.5	0.87	0.67	0.03	0.46	240	<2
97BMF-101-15-f	61	10	1.8	2.2	3.5	0.76	1.8	0.04	0.37	240	<2
97BMF-101-15-g	64	9.8	0.62	3.6	1.3	0.69	0.63	0.02	0.45	190	<2
97BMF-101-16-a	12	6.9	0.97	2.3	1.9	0.55	0.99	0.12	0.41	190	3
97BMF-101-16-b	31	8.0	1.6	2.4	3.0	0.75	1.5	0.08	0.40	270	<2
97BMF-101-16-c	40	9.0	1.2	3.0	1.9	1.0	1.1	0.08	0.55	320	<2
97BMF-101-16-d	56	9.7	1.2	3.1	1.9	1.0	1.1	0.03	0.64	340	<2
97BMF-101-17-a	6	5.9	1.1	2.9	2.5	0.37	1.1	0.04	0.29	170	10
97BMF-101-17-b	17	7.1	1.3	4.0	2.3	0.68	1.3	0.06	0.46	280	2
97BMF-101-17-c	30	7.4	1.1	4.4	2.1	0.74	1.2	0.08	0.46	250	2
97BMF-101-17-d	44	6.4	1.4	2.8	0.57	1.3	0.06	0.34	210	<2	
97BMF-101-17-e	58	7.1	1.6	2.5	3.2	0.50	1.6	0.07	0.37	270	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm
97BMF-101-13-a	3300	240	21	32	< 2	< 2	59	< 4	21	15	3
97BMF-101-13-b	8700	360	60	< 5	< 2	< 2	510	7	17	19	13
97BMF-101-13-c	47000	36	310	< 5	8	< 2	2900	< 4	11	14	30
97BMF-101-13-d	17000	200	120	< 5	3	< 2	2500	< 4	12	17	10
97BMF-101-13-e	26000	290	180	23	6	< 2	2200	< 4	18	14	9
97BMF-101-13-f	35000	480	320	20	6	< 2	4800	15	22	17	12
97BMF-101-13-g	37000	450	150	39	5	5	1800	11	27	16	17
97BMF-101-14-a	7200	200	55	18	< 2	< 2	85	< 4	17	17	6
97BMF-101-14-b	63000	260	370	< 5	< 2	< 2	340	< 4	14	13	19
97BMF-101-14-c	35000	440	200	< 5	< 2	< 2	160	10	18	13	29
97BMF-101-14-d	2800	190	18	< 2	< 2	< 2	28	< 4	13	17	3
97BMF-101-15-a	11000	670	60	43	< 2	5	220	9	25	18	3
97BMF-101-15-b	31000	360	200	26	< 2	6	260	5	22	15	11
97BMF-101-15-c	11000	460	61	39	3	15	380	17	20	32	< 2
97BMF-101-15-d	1900	740	9	55	4	9	200	19	28	35	< 2
97BMF-101-15-e	2900	560	15	83	7	32	590	22	46	64	< 2
97BMF-101-15-f	1600	980	7	77	5	2	190	17	47	37	< 2
97BMF-101-15-g	3500	570	19	120	4	13	520	20	72	51	< 2
97BMF-101-16-a	5400	530	27	46	3	8	150	15	25	29	< 2
97BMF-101-16-b	2800	790	13	61	5	3	76	17	31	37	< 2
97BMF-101-16-c	3600	550	18	67	7	11	160	21	33	57	< 2
97BMF-101-16-d	3600	620	19	78	7	20	250	25	39	60	< 2
97BMF-101-17-a	15000	660	77	35	< 2	3	65	9	20	17	5
97BMF-101-17-b	13000	590	68	46	4	9	62	19	25	24	< 2
97BMF-101-17-c	13000	560	69	51	5	13	65	18	26	32	< 2
97BMF-101-17-d	3600	650	17	44	3	< 2	29	13	22	21	< 2
97BMF-101-17-e	5000	790	24	53	3	< 2	27	14	28	20	< 2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101-13-a	< 4	14	< 3	9800	2	17	< 6	14	< 2	< 1	490
97BMF-101-13-b	< 4	13	< 3	44000	3	19	6	14	< 2	< 1	2000
97BMF-101-13-c	< 4	10	< 3	50000	3	13	8	< 2	< 2	< 1	7300
97BMF-101-13-d	< 4	9	< 3	28000	< 2	12	8	< 2	< 2	< 1	4200
97BMF-101-13-e	< 4	13	< 3	17000	3	21	8	10	2	< 1	5900
97BMF-101-13-f	< 4	17	< 3	31000	7	29	17	30	5	< 1	12000
97BMF-101-13-g	7	35	7	11000	12	56	18	110	19	3	28000
97BMF-101-14-a	< 4	11	< 3	20000	< 2	11	< 6	11	< 2	< 1	2400
97BMF-101-14-b	< 4	11	< 3	55000	2	7	8	< 2	< 2	< 1	1300
97BMF-101-14-c	< 4	17	< 3	93000	4	11	7	21	2	< 1	290
97BMF-101-14-d	< 4	9	< 3	9100	< 2	5	< 6	8	< 2	< 1	250
97BMF-101-15-a	5	17	4	6500	5	230	11	33	6	< 1	210
97BMF-101-15-b	< 4	15	< 3	18000	4	84	9	18	4	< 1	450
97BMF-101-15-c	5	20	8	800	15	130	22	73	11	2	170
97BMF-101-15-d	12	27	8	90	15	260	21	79	15	2	150
97BMF-101-15-e	4	54	15	140	22	130	37	160	30	4	300
97BMF-101-15-f	13	39	8	90	13	390	20	97	21	3	160
97BMF-101-15-g	9	80	13	190	24	150	40	180	52	6	250
97BMF-101-16-a	8	22	6	790	13	200	23	60	12	2	130
97BMF-101-16-b	10	27	7	75	11	320	20	87	15	2	160
97BMF-101-16-c	11	35	12	110	18	210	30	120	19	3	260
97BMF-101-16-d	12	43	14	150	19	220	38	140	23	3	300
97BMF-101-17-a	< 4	14	4	1600	7	230	12	43	7	1	76
97BMF-101-17-b	5	18	7	270	12	270	21	79	11	1	97
97BMF-101-17-c	< 4	21	9	300	13	230	25	75	11	2	120
97BMF-101-17-d	< 4	17	5	160	8	280	12	58	10	1	80
97BMF-101-17-e	9	20	5	130	7	340	15	54	11	1	77

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

FieldNo	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101-18-a	5	5.3	0.68	2.5	1.7	0.48	0.62	0.07	0.29	210	33
97BMF-101-18-b	16	8.0	1.2	3.2	2.1	0.85	1.1	0.09	0.44	320	2
97BMF-101-18-c	28	8.6	1.7	3.9	1.9	1.1	1.3	0.07	0.58	460	<2
97BMF-101-18-d	39	8.5	1.7	2.9	2.2	1.0	1.6	0.05	0.50	400	<2
97BMF-101-18-e	47	8.2	1.6	2.9	2.3	0.90	1.4	0.06	0.49	360	<2
97BMF-101-18-f	59	9.6	1.3	3.4	1.5	0.88	1.1	0.03	0.54	320	<2
97BMF-101A1-a	2	4.0	0.34	1.6	1.6	0.16	0.46	0.03	0.16	130	29
97BMF-101A1-b	10	7.3	1.1	2.1	2.5	0.29	1.5	0.09	0.29	110	<2
97BMF-101A1-c	23	6.4	0.90	2.1	1.9	0.37	1.2	0.05	0.25	140	<2
97BMF-101A1-d	40	8.4	1.2	2.1	2.4	0.57	1.5	0.06	0.34	280	<2
97BMF-101A2-a	6	3.9	0.21	1.3	1.7	0.15	0.29	0.02	0.14	120	42
97BMF-101A2-b	12	6.0	0.03	1.8	2.7	0.20	0.06	0.02	0.13	160	100
97BMF-101A2-c	23	6.3	0.66	1.8	1.4	0.45	0.73	0.11	0.35	150	<2
97BMF-101A2-d	35	9.3	0.89	2.7	1.7	0.88	0.89	0.11	0.52	240	<2
97BMF-101A2-e	46	8.7	1.3	2.7	1.9	1.1	1.2	0.05	0.60	330	<2
97BMF-101A2-f	58	9.1	1.6	2.6	2.2	1.0	1.4	0.02	0.56	340	<2
97BMF-101A2-g	63	9.7	0.89	2.8	1.5	0.70	0.90	0.009	0.50	220	<2
97BMF-101A3-a	7	6.7	1.1	2.8	2.1	0.40	1.2	0.14	0.40	170	<2
97BMF-101A3-b	21	7.7	1.2	2.5	2.3	0.56	1.3	0.12	0.44	220	<2
97BMF-101A3-c	31	8.5	1.2	2.8	2.2	0.92	1.2	0.11	0.52	290	<2
97BMF-101A3-d	36	7.9	1.7	3.0	2.7	0.97	1.5	0.11	0.49	320	<2
97BMF-101A3-e	42	8.0	1.3	2.8	2.5	0.80	1.2	0.07	0.42	270	<2
97BMF-101A3-f	56	8.0	1.6	3.5	2.5	1.0	1.4	0.05	0.48	370	<2
97BMF-101A4-a	6	6.5	1.1	3.9	2.1	0.53	1.1	0.08	0.39	230	10
97BMF-101A4-b	16	6.8	1.2	4.2	2.4	0.58	1.3	0.06	0.40	220	4
97BMF-101A4-c	26	7.1	1.3	4.4	2.3	0.73	1.3	0.09	0.45	260	3
97BMF-101A4-d	38	6.9	1.3	2.7	3.0	0.44	1.4	0.07	0.28	260	<2
97BMF-101A4-e	45	7.2	1.3	5.2	2.0	0.87	1.2	0.10	0.52	330	3
97BMF-101A4-f	53	7.3	1.1	6.1	1.7	0.95	1.2	0.08	0.54	420	3
97BMF-101A4-g	62	7.5	1.4	5.1	1.9	1.0	1.3	0.05	0.58	430	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm
97BMF-101-18-a	7100	430	36	47	3	7	150	10	31	27	4
97BMF-101-18-b	1300	590	6	83	7	11	180	15	55	41	<2
97BMF-101-18-c	120	530	<2	110	9	13	190	21	69	43	<2
97BMF-101-18-d	170	620	<2	100	8	10	120	18	62	35	<2
97BMF-101-18-e	28	600	<2	100	7	11	130	18	56	38	<2
97BMF-101-18-f	49	560	<2	110	6	13	190	20	72	47	<2
97BMF-101A1-a	5800	390	32	44	<2	2	70	7	27	17	<2
97BMF-101A1-b	6000	970	29	51	<2	10	130	16	36	20	<2
97BMF-101A1-c	500	740	<2	50	2	5	140	>	13	36	<2
97BMF-101A1-d	61	520	<2	82	4	9	310	17	58	35	<2
97BMF-101A2-a	7300	380	40	39	<2	<2	120	6	24	16	3
97BMF-101A2-b	13000	400	65	33	<2	<2	110	12	26	17	9
97BMF-101A2-c	3700	480	18	43	2	8	170	15	22	29	<2
97BMF-101A2-d	2200	590	11	72	6	15	270	20	37	58	<2
97BMF-101A2-e	770	630	6	130	8	13	340	21	82	57	<2
97BMF-101A2-f	480	640	5	98	7	11	120	15	61	40	<2
97BMF-101A2-g	770	640	12	120	5	10	350	20	83	52	<2
97BMF-101A3-a	17000	610	130	44	<2	8	140	12	23	21	<2
97BMF-101A3-b	8300	620	42	52	3	19	120	22	28	29	<2
97BMF-101A3-c	3500	560	18	69	6	14	140	16	36	49	<2
97BMF-101A3-d	4700	590	23	64	7	21	180	17	32	40	<2
97BMF-101A3-e	3800	640	19	59	6	4	200	16	31	39	<2
97BMF-101A3-f	2500	620	12	74	8	19	130	19	39	41	<2
97BMF-101A4-a	20000	540	100	47	3	8	76	10	25	21	5
97BMF-101A4-b	23000	610	120	39	3	15	62	15	20	23	2
97BMF-101A4-c	16000	620	82	54	4	12	78	20	28	29	<2
97BMF-101A4-d	10000	790	52	48	2	6	36	12	27	18	<2
97BMF-101A4-e	15000	550	74	62	6	20	96	20	30	36	<2
97BMF-101A4-f	9800	590	48	56	8	26	220	15	26	47	<2
97BMF-101A4-g	1800	590	7	56	8	14	180	17	27	38	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101-18-a	< 4	22	5	6900	8	140	15	56	15	2	210
97BMF-101-18-b	9	43	11	370	14	230	25	100	38	4	250
97BMF-101-18-c	9	64	13	120	18	250	50	140	53	6	260
97BMF-101-18-d	11	55	10	110	14	310	25	99	40	4	240
97BMF-101-18-e	12	52	10	85	15	280	24	110	37	4	230
97BMF-101-18-f	10	63	13	160	21	210	32	160	62	5	470
97BMF-101A1-a	< 4	18	< 3	2700	4	120	8	24	6	< 1	190
97BMF-101A1-b	9	34	5	380	8	420	14	36	11	2	130
97BMF-101A1-c	9	40	6	38	7	340	13	52	13	2	140
97BMF-101A1-d	11	64	9	64	13	360	18	64	23	3	190
97BMF-101A2-a	< 4	16	< 3	6600	4	92	7	22	3	< 1	210
97BMF-101A2-b	< 4	18	< 3	17000	5	46	13	32	3	< 1	270
97BMF-101A2-c	8	24	7	400	12	160	19	65	11	2	130
97BMF-101A2-d	9	50	13	270	18	180	35	120	24	4	240
97BMF-101A2-e	11	88	14	130	18	230	30	130	62	7	280
97BMF-101A2-f	12	49	11	130	17	280	28	120	44	4	290
97BMF-101A2-g	8	72	12	150	20	190	35	150	65	6	420
97BMF-101A3-a	< 4	22	4	1300	13	240	25	49	11	2	120
97BMF-101A3-b	9	26	6	530	15	270	26	63	12	2	130
97BMF-101A3-c	7	33	11	330	15	240	25	91	16	2	210
97BMF-101A3-d	12	35	10	360	12	300	21	100	16	2	190
97BMF-101A3-e	6	29	10	130	13	250	23	130	18	2	210
97BMF-101A3-f	6	35	11	98	13	280	28	120	22	3	310
97BMF-101A4-a	< 4	18	6	1100	10	220	12	54	10	1	82
97BMF-101A4-b	< 4	15	6	380	10	250	17	56	9	1	84
97BMF-101A4-c	6	20	8	370	12	240	23	79	11	2	110
97BMF-101A4-d	< 4	16	5	220	7	320	14	45	8	1	64
97BMF-101A4-e	< 4	25	10	290	14	220	29	96	14	2	130
97BMF-101A4-f	< 4	24	14	240	14	210	31	140	13	2	180
97BMF-101A4-g	< 4	23	12	110	14	240	26	140	13	2	190

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont.).

Field No	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101A5-a	8	6.5	1.3	1.9	2.6	0.42	1.3	0.09	0.37	170	4
97BMF-101A5-b	19	7.1	1.5	2.4	3.0	0.57	1.5	0.12	0.33	230	<2
97BMF-101A5-c	28	6.9	1.5	2.4	3.1	0.56	1.5	0.05	0.31	220	<2
97BMF-101A5-d	39	6.9	1.4	2.6	3.3	0.58	1.5	0.05	0.28	210	<2
97BMF-101A5-e	45	7.9	1.9	3.5	2.8	1.0	1.7	0.05	0.48	330	<2
97BMF-101A5-f	52	6.9	1.6	2.0	3.2	0.53	1.6	0.04	0.26	200	<2
97BMF-101A6-a	5	4.9	0.86	3.8	2.0	0.29	0.84	0.04	0.26	230	53
97BMF-101A6-b	12	7.1	1.3	1.5	2.3	0.49	1.3	0.08	0.37	200	5
97BMF-101A6-c	23	7.8	1.5	2.2	2.7	0.78	1.4	0.05	0.42	270	<2
97BMF-101A6-d	38	6.7	1.3	1.1	3.2	0.37	1.4	0.03	0.25	140	<2
97BMF-101A6-e	47	8.5	1.5	2.8	2.0	0.94	1.4	0.06	0.53	330	<2
97BMF-101A6-f	52	7.5	1.6	1.4	3.3	0.51	1.6	0.03	0.29	190	<2
97BMF-101A6-g	56	7.7	0.96	2.0	1.7	0.63	1.2	0.02	0.42	210	<2
97BMF-101B1-a	5	3.3	0.006	0.90	1.5	0.11	0.01	0.006	0.09	99	70
97BMF-101B1-b	13	2.8	0.007	1.2	1.3	0.09	0.02	0.008	0.08	86	80
97BMF-101B1-c	19	2.8	0.01	2.1	1.2	0.09	0.03	<0.005	0.07	120	180
97BMF-101B2-a	3	2.7	0.008	1.4	1.2	0.09	0.01	<0.005	0.07	97	77
97BMF-101B2-b	14	3.0	<0.005	1.5	1.4	0.10	0.01	0.006	0.07	120	86
97BMF-101B2-c	28	5.8	0.70	2.7	2.0	0.36	1.0	0.17	0.26	150	22
97BMF-101B2-d	43	8.1	1.0	2.5	2.4	0.56	1.2	0.06	0.34	230	<2
97BMF-101B2-e	59	8.0	1.2	1.6	2.6	0.49	1.5	0.02	0.32	200	<2
97BMF-101B4-a	3	5.4	0.49	2.4	1.5	0.33	0.51	0.13	0.29	160	36
97BMF-101B4-b	17	7.0	1.2	2.7	1.8	0.68	1.1	0.09	0.43	240	9
97BMF-101B4-c	31	6.6	1.3	1.3	3.3	0.35	1.4	0.05	0.20	130	<2
97BMF-101B4-d	38	8.8	1.3	3.0	1.7	1.0	1.2	0.06	0.55	320	<2
97BMF-101B4-e	44	11	0.54	3.4	1.3	0.71	0.57	0.06	0.46	180	<2
97BMF-101B4-f	47	8.5	1.6	3.3	1.9	1.0	1.4	0.05	0.60	360	<2
97BMF-101B4-g	55	6.9	1.6	1.1	3.4	0.34	1.6	0.03	0.18	140	<2
97BMF-101B4-h	64	7.2	1.6	2.4	2.9	0.67	1.5	0.05	0.45	320	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mn ppm	Mo ppm
97BMF-101A5-a	6100	630	31	47	<2	7	83	13	26	18	<2	
97BMF-101A5-b	5300	710	26	42	3	13	54	10	22	21	<2	
97BMF-101A5-c	3300	710	15	44	4	5	37	12	23	19	<2	
97BMF-101A5-d	1600	780	6	38	4	<2	39	13	19	19	<2	
97BMF-101A5-e	1600	610	6	59	7	7	70	18	31	29	<2	
97BMF-101A5-f	580	770	<2	41	4	4	32	14	21	18	<2	
97BMF-101A6-a	22000	460	120	37	<2	11	110	10	27	16	8	
97BMF-101A6-b	1200	580	5	53	2	22	470	17	27	23	<2	
97BMF-101A6-c	480	670	<2	54	5	13	230	13	26	32	<2	
97BMF-101A6-d	160	830	<2	54	<2	2	46	10	29	17	<2	
97BMF-101A6-e	390	640	<2	70	6	15	170	21	33	43	<2	
97BMF-101A6-f	170	870	<2	43	3	2	60	12	23	18	<2	
97BMF-101A6-g	470	590	<2	62	4	8	320	14	27	39	<2	
97BMF-101B1-a	5000	190	27	25	<2	<2	61	7	17	18	4	
97BMF-101B1-b	8300	190	44	27	<2	<2	35	4	18	19	4	
97BMF-101B1-c	17000	250	91	10	<2	<2	140	<4	18	17	14	
97BMF-101B2-a	10000	210	52	22	<2	<2	52	<4	15	20	6	
97BMF-101B2-b	11000	260	56	23	<2	<2	41	5	19	19	7	
97BMF-101B2-c	9200	670	7	42	<2	14	200	9	30	19	4	
97BMF-101B2-d	720	750	3	69	3	7	230	16	44	35	3	
97BMF-101B2-e	100	830	<2	53	3	6	150	15	36	31	<2	
97BMF-101B4-a	13000	380	71	38	<2	8	260	14	24	21	6	
97BMF-101B4-b	5700	520	29	53	4	8	160	18	29	33	<2	
97BMF-101B4-c	2000	810	9	37	2	<2	36	12	19	16	<2	
97BMF-101B4-d	2000	570	10	86	7	16	290	21	43	54	<2	
97BMF-101B4-e	2500	550	14	99	5	12	390	21	55	74	<2	
97BMF-101B4-f	1900	570	9	98	8	22	120	18	54	53	<2	
97BMF-101B4-g	230	940	<2	43	<2	19	9	23	16	<2		
97BMF-101B4-h	390	710	<2	80	5	5	57	17	45	22	<2	

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101A5-a	6	17	4	690	10	260	19	43	8	1	72
97BMF-101A5-b	4	18	6	62	9	310	16	67	10	1	83
97BMF-101A5-c	6	18	6	48	8	320	13	74	9	1	89
97BMF-101A5-d	5	16	6	46	7	320	13	79	9	1	80
97BMF-101A5-e	9	23	10	79	11	330	19	110	13	2	130
97BMF-101A5-f	7	15	5	65	6	340	11	59	9	1	64
97BMF-101A6-a	< 4	16	< 3	12000	7	200	12	55	6	< 1	260
97BMF-101A6-b	8	27	5	580	13	260	19	51	11	2	130
97BMF-101A6-c	9	25	8	140	21	290	25	65	13	2	150
97BMF-101A6-d	10	20	3	58	7	310	14	33	8	1	65
97BMF-101A6-e	10	29	10	85	18	260	32	91	16	2	180
97BMF-101A6-f	9	17	4	48	8	350	14	43	10	1	81
97BMF-101A6-g	9	30	9	100	16	200	26	75	15	2	180
97BMF-101B1-a	< 4	12	< 3	11000	3	25	< 6	19	< 2	< 1	230
97BMF-101B1-b	< 4	13	< 3	11000	2	25	< 6	15	2	< 1	180
97BMF-101B1-c	< 4	11	< 3	31000	2	55	< 6	10	< 2	< 1	190
97BMF-101B2-a	< 4	10	< 3	12000	< 2	30	< 6	11	< 2	< 1	310
97BMF-101B2-b	< 4	12	< 3	17000	2	41	< 6	13	< 2	< 1	300
97BMF-101B2-c	12	31	6	630	10	220	15	60	12	2	160
97BMF-101B2-d	11	41	9	83	11	270	21	76	23	3	210
97BMF-101B2-e	10	30	7	98	9	330	17	52	16	2	140
97BMF-101B4-a	< 4	17	3	7700	11	120	18	43	7	1	460
97BMF-101B4-b	7	23	7	2000	13	210	22	73	13	2	250
97BMF-101B4-c	4	15	3	67	5	320	9	40	9	1	83
97BMF-101B4-d	9	45	13	130	19	220	32	140	31	4	320
97BMF-101B4-e	11	58	14	170	24	130	42	180	40	5	440
97BMF-101B4-f	12	46	11	130	17	270	30	140	28	3	350
97BMF-101B4-g	8	16	< 3	40	5	360	9	31	9	1	73
97BMF-101B4-h	8	30	6	44	9	320	17	75	14	2	150

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

FieldNo	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101B5-a	5	3.4	0.04	0.74	1.5	0.12	0.05	0.01	0.10	100	33
97BMF-101B5-b	17	6.6	1.4	3.7	2.1	0.78	1.2	0.13	0.41	180	6
97BMF-101B5-c	27	7.2	1.4	4.6	2.3	0.82	1.3	0.12	0.43	370	<2
97BMF-101B5-d	45	6.6	1.3	0.92	3.4	0.35	1.4	0.03	0.20	130	<2
97BMF-101B5-e	62	7.9	1.6	3.1	2.4	0.92	1.4	0.08	0.45	350	<2
97BMF-101B6-a	3	7.2	1.1	3.3	2.1	0.78	1.0	0.12	0.39	360	5
97BMF-101B6-b	15	7.9	1.5	2.2	2.8	0.78	1.4	0.05	0.41	320	<2
97BMF-101B6-c	25	7.3	1.7	4.5	2.3	0.94	1.5	0.07	0.46	330	<2
97BMF-101B6-d	34	6.9	1.5	1.7	3.1	0.54	1.5	0.04	0.29	220	<2
97BMF-101B6-e	45	6.6	1.4	2.5	3.2	0.44	1.5	0.03	0.26	190	<2
97BMF-101B6-f	55	8.0	1.4	3.5	2.0	0.93	1.3	0.04	0.56	340	<2
97BMF-101B6-g	64	6.6	1.4	2.6	3.1	0.50	1.4	0.03	0.31	190	<2
97BMF-101B7-a	3	6.6	0.75	3.9	2.5	0.44	0.79	0.07	0.24	270	120
97BMF-101B7-b	8	8.6	0.17	4.2	3.7	0.36	0.17	0.05	0.17	290	92
97BMF-101B7-c	14	8.2	1.2	5.7	2.1	1.1	1.0	0.14	0.55	470	13
97BMF-101B7-d	22	7.3	1.2	1.3	3.2	0.44	1.4	0.02	0.26	150	<2
97BMF-101B7-e	33	8.3	1.5	3.5	2.3	1.0	1.3	0.06	0.49	400	<2
97BMF-101B7-f	52	8.3	1.6	3.9	2.5	1.2	1.4	0.07	0.53	550	<2
97BMF-101C1-a	8	7.5	0.07	4.0	3.3	0.27	0.11	0.05	0.12	230	150
97BMF-101C1-b	17	3.0	0.15	0.84	0.34	0.17	0.09	0.13	0.10	50	13
97BMF-101C1-c	21	6.2	0.15	2.8	0.42	0.33	0.11	0.08	0.17	67	5
97BMF-101C1-d	28	4.3	0.14	1.1	0.34	0.20	0.15	0.13	0.15	60	3
97BMF-101C1-e	37	9.5	0.67	2.5	1.3	0.71	0.74	0.05	0.50	180	<2
97BMF-101C1-f	51	9.8	0.40	3.8	1.1	0.67	0.43	0.03	0.42	140	<2
97BMF-101C1-g	64	6.8	1.3	0.78	3.6	0.28	1.5	0.03	0.15	110	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm
97BMF-101B5-a	2900	200	17	31	< 2	< 2	42	5	19	17	3
97BMF-101B5-b	1800	510	8	49	5	10	160	13	26	27	< 2
97BMF-101B5-c	790	350	<2	54	5	12	140	17	27	30	< 2
97BMF-101B5-d	100	890	<2	43	< 2	< 2	26	10	25	20	< 2
97BMF-101B5-e	220	620	<2	88	6	9	120	17	47	36	< 2
97BMF-101B6-a	3500	510	19	60	5	20	210	16	34	36	3
97BMF-101B6-b	160	670	<2	73	6	18	110	17	42	40	< 2
97BMF-101B6-c	2300	590	10	67	6	9	120	16	36	32	< 2
97BMF-101B6-d	5	800	<2	53	3	3	50	10	28	21	< 2
97BMF-101B6-e	45	810	<2	40	2	< 2	63	12	21	18	< 2
97BMF-101B6-f	15	600	<2	69	6	22	150	14	35	42	< 2
97BMF-101B6-g	5	780	<2	45	3	< 2	77	14	25	19	< 2
97BMF-101B7-a	19000	530	97	39	2	4	140	12	30	21	14
97BMF-101B7-b	24000	670	130	28	< 2	3	71	18	24	19	17
97BMF-101B7-c	3100	470	13	74	9	25	160	19	37	39	6
97BMF-101B7-d	120	910	<2	54	3	< 2	59	11	28	31	< 2
97BMF-101B7-e	41	590	<2	86	8	5	49	13	48	42	< 2
97BMF-101B7-f	21	610	<2	100	11	15	38	19	57	42	< 2
97BMF-101C1-a	28000	500	140	26	< 2	6	160	15	25	22	18
97BMF-101C1-b	210	150	<2	54	< 1	1	1000	9	36	13	6
97BMF-101C1-c	6000	360	34	129	2	23	1200	16	73	26	< 2
97BMF-101C1-d	490	200	2	55	< 2	17	190	10	32	19	< 2
97BMF-101C1-e	650	490	2	89	4	14	170	18	57	51	< 2
97BMF-101C1-f	840	550	3	120	5	12	430	23	63	60	< 2
97BMF-101C1-g	220	990	<2	40	< 2	< 2	26	10	23	15	< 2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101B5-a	<4	13	<3	6900	3	32	<6	20	2	<1	180
97BMF-101B5-b	4	21	9	860	11	230	17	90	12	2	200
97BMF-101B5-c	<4	23	9	200	11	260	17	90	13	2	190
97BMF-101B5-d	10	17	3	30	5	320	10	30	11	1	52
97BMF-101B5-e	8	38	10	240	14	270	25	97	22	3	180
97BMF-101B6-a	5	28	10	990	13	200	21	94	23	2	290
97BMF-101B6-b	18	31	8	94	11	280	20	95	21	2	260
97BMF-101B6-c	<4	26	10	120	11	290	16	100	15	2	220
97BMF-101B6-d	6	21	5	44	7	320	12	46	11	2	120
97BMF-101B6-e	5	16	4	66	6	320	9	32	9	1	97
97BMF-101B6-f	10	31	10	78	14	250	25	88	18	2	220
97BMF-101B6-g	7	19	5	52	7	310	10	42	11	1	110
97BMF-101B7-a	<4	21	4	22000	8	170	16	53	10	1	120
97BMF-101B7-b	<4	16	<3	23000	8	70	16	47	5	<1	83
97BMF-101B7-c	5	34	14	2100	19	180	33	140	20	2	170
97BMF-101B7-d	9	25	5	68	7	310	13	41	13	2	120
97BMF-101B7-e	16	40	12	130	15	260	25	130	26	3	230
97BMF-101B7-f	8	48	13	100	15	280	25	120	34	4	270
97BMF-101C1-a	15	17	<3	24000	6	76	19	65	4	<1	530
97BMF-101C1-b	<4	39	4	3200	11	33	13	30	22	3	220
97BMF-101C1-c	<4	88	11	720	17	45	23	44	44	6	230
97BMF-101C1-d	5	32	5	68	17	37	22	34	22	3	110
97BMF-101C1-e	21	45	10	90	19	130	35	110	34	3	190
97BMF-101C1-f	10	75	14	140	25	100	44	170	41	5	250
97BMF-101C1-g	8	15	<3	61	4	340	10	23	9	1	45

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

FieldNo	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
97BMF-101C2-a	3	5.8	0.13	4.8	2.2	0.24	0.17	0.08	0.15	170	100
97BMF-101C2-b	9	11	< 0.005	2.8	5.1	0.36	0.03	0.03	0.13	320	130
97BMF-101C2-c	15	3.1	0.11	3.4	0.33	0.18	0.12	0.21	0.12	48	25
97BMF-101C2-d	22	4.3	0.19	1.9	0.62	0.24	0.24	0.16	0.17	57	3
97BMF-101C2-e	28	6.4	1.1	1.5	3.1	0.31	1.2	0.05	0.21	110	<2
97BMF-101C2-f	34	8.1	1.0	4.0	1.9	0.87	1.0	0.06	0.47	240	<2
97BMF-101C2-g	40	7.3	1.6	1.3	3.4	0.49	1.6	0.03	0.25	210	<2
97BMF-101C2-h	45	6.7	1.1	1.5	3.1	0.40	1.2	0.02	0.24	130	<2
97BMF-101C2-i	53	7.0	1.3	1.0	3.6	0.34	1.5	0.02	0.17	120	<2
97BMF-101C2-j	62	7.2	1.2	1.3	3.0	0.45	1.4	0.02	0.26	150	<2
97BMF-101C3-a	4	5.4	0.08	3.4	2.4	0.20	0.11	0.04	0.12	150	86
97BMF-101C3-b	15	6.8	0.47	3.1	1.0	0.44	0.47	0.14	0.29	120	3
97BMF-101C3-c	26	7.1	0.65	2.6	1.6	0.50	0.70	0.10	0.32	150	<2
97BMF-101C3-d	33	7.7	1.2	2.4	2.5	0.67	1.3	0.05	0.38	220	<2
97BMF-101C3-e	43	8.8	2.0	3.3	2.2	1.4	1.7	0.07	0.67	440	<2
97BMF-101C3-f	58	7.9	1.8	2.6	2.6	1.0	1.6	0.06	0.60	430	<2
97BMF-101C4-a	6	6.8	0.55	5.1	2.4	0.48	0.55	0.10	0.27	200	54
97BMF-101C4-b	18	7.0	0.74	4.9	1.6	0.66	0.74	0.11	0.36	220	3
97BMF-101C4-c	31	8.1	1.2	3.5	2.3	0.82	1.2	0.06	0.43	270	<2
97BMF-101C4-d	47	7.0	1.4	1.8	3.2	0.61	1.4	0.04	0.31	200	<2
97BMF-101C4-e	61	6.4	1.2	1.7	3.5	0.50	1.4	0.03	0.25	160	<2
97BMF-101C5-a	5	6.7	1.2	3.6	3.2	0.48	1.3	0.05	0.26	220	34
97BMF-101C5-b	14	7.5	0.93	5.4	3.3	0.48	0.96	0.05	0.25	250	70
97BMF-101C5-c	21	7.9	0.80	4.6	3.5	0.48	0.81	0.05	0.25	250	65
97BMF-101C5-d	30	8.6	0.38	4.8	3.8	0.43	0.40	0.05	0.23	260	87
97BMF-101C5-e	42	6.4	1.4	2.5	3.2	0.43	1.5	0.04	0.23	190	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm
97BMF-101C2-a	38000	450	200	27	<2	4	190	10	22	20	12
97BMF-101C2-b	13000	870	67	34	<2	<2	30	22	30	21	15
97BMF-101C2-c	21000	240	110	41	<2	9	740	7	20	15	7
97BMF-101C2-d	3400	270	15	32	<2	18	150	11	17	21	<2
97BMF-101C2-e	2500	830	12	39	<2	3	43	12	21	16	<2
97BMF-101C2-f	2600	580	12	77	6	14	130	18	40	42	<2
97BMF-101C2-g	5	930	<2	62	3	<2	37	14	34	22	<2
97BMF-101C2-h	640	870	2	47	2	<2	47	8	25	27	<2
97BMF-101C2-i	260	960	<2	42	<2	<2	24	10	23	19	<2
97BMF-101C2-j	130	870	<2	53	4	<2	61	16	27	32	28
97BMF-101C3-a	21000	650	120	30	<2	4	180	9	26	20	10
97BMF-101C3-b	1700	400	11	50	4	19	390	19	25	35	<2
97BMF-101C3-c	160	520	<2	49	3	26	130	15	25	35	<2
97BMF-101C3-d	74	710	<2	57	4	19	69	16	30	31	<2
97BMF-101C3-e	220	530	<2	84	9	11	87	16	44	45	<2
97BMF-101C3-f	180	610	<2	110	7	6	59	14	65	32	<2
97BMF-101C4-a	17000	410	85	45	3	9	310	12	26	25	10
97BMF-101C4-b	960	440	4	51	4	25	200	16	27	34	<2
97BMF-101C4-c	46	600	<2	61	5	11	100	18	33	38	2
97BMF-101C4-d	44	760	<2	52	4	<2	33	13	28	22	<2
97BMF-101C4-e	82	780	<2	36	4	9	24	9	20	18	4
97BMF-101C5-a	7600	700	36	37	3	8	120	9	21	17	3
97BMF-101C5-b	16000	640	74	40	3	4	170	14	23	19	6
97BMF-101C5-c	17000	640	76	45	2	2	170	15	29	19	9
97BMF-101C5-d	21000	600	100	37	<2	4	99	13	27	20	10
97BMF-101C5-e	1800	740	7	50	4	<2	25	11	29	15	<2

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
97BMF-101C2-a	< 4	15	< 3	19000	6	94	16	30	4	< 1	420
97BMF-101C2-b	9	19	< 3	26000	8	110	26	52	4	< 1	420
97BMF-101C2-c	< 4	27	7	2300	15	34	23	25	13	2	140
97BMF-101C2-d	7	18	6	280	20	55	26	58	11	1	120
97BMF-101C2-e	6	17	4	150	7	270	11	45	9	1	68
97BMF-101C2-f	5	42	11	150	15	200	27	150	23	3	190
97BMF-101C2-g	11	23	4	34	7	350	12	43	11	2	110
97BMF-101C2-h	7	21	4	72	6	270	12	45	11	1	91
97BMF-101C2-i	8	16	< 3	34	5	330	9	29	9	1	66
97BMF-101C2-j	9	25	5	68	6	300	15	40	13	2	120
97BMF-101C3-a	< 4	15	< 3	17000	5	110	12	28	4	< 1	520
97BMF-101C3-b	5	28	10	310	16	100	25	87	16	2	230
97BMF-101C3-c	6	27	8	84	16	150	26	80	16	2	220
97BMF-101C3-d	16	29	7	83	12	170	21	120	16	2	180
97BMF-101C3-e	23	44	12	140	16	320	29	160	28	3	290
97BMF-101C3-f	19	46	9	92	14	310	39	120	24	3	220
97BMF-101C4-a	13	22	6	5300	10	130	21	100	12	2	270
97BMF-101C4-b	16	26	10	250	14	150	23	150	16	2	260
97BMF-101C4-c	18	30	9	96	14	240	25	150	17	2	230
97BMF-101C4-d	15	22	7	54	8	300	13	65	12	2	120
97BMF-101C4-e	12	14	23	32	5	300	10	53	8	1	110
97BMF-101C5-a	11	17	8	3900	7	180	13	79	9	1	99
97BMF-101C5-b	10	18	5	8100	8	200	19	100	8	1	140
97BMF-101C5-c	11	19	4	12000	8	180	21	91	8	1	149
97BMF-101C5-d	15	19	< 3	16000	9	110	21	93	7	< 1	140
97BMF-101C5-e	11	18	10	360	5	330	12	67	8	1	56

Table 5 Concentration data for total digestions of tailings core samples by ICP-AES, upper Basin Creek, Buckeye meadow, Montana (cont)

FieldNo	DEPTH (cm)	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm
98BMF 102A1-a	0	5.7	0.39	1.4	0.80	0.39	0.44	0.23	0.26	140	<2
98BMF 102A1-b	10	9.4	0.89	3.1	1.4	1.0	0.88	0.15	0.50	310	<2
98BMF 102A1-c	19	9.5	0.77	3.8	1.4	0.96	0.81	0.07	0.48	300	<2
98BMF 102A1-d	28	7.7	1.5	2.7	2.6	0.98	1.4	0.04	0.46	370	<2
98BMF 102A1-e	36	7.4	1.4	1.7	2.8	0.68	1.5	0.04	0.34	290	<2
98BMF 102A1-f	47	7.1	1.4	1.8	3.1	0.54	1.5	0.04	0.30	230	<2
98BMF 102A1-g	59	6.6	1.2	1.6	3.4	0.39	1.5	0.04	0.21	160	<2
98BMF 102A1-h	72	6.4	1.1	1.8	3.2	0.44	1.3	0.05	0.22	180	<2

Field Number	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm
98BMF 102A1-a	11000	250	260	35	7	34	52	15	21	31	4
98BMF 102A1-b	3700	510	2	79	14	47	70	21	47	71	<2
98BMF 102A1-c	3400	580	10	120	13	48	76	21	86	65	<2
98BMF 102A1-d	1100	620	4	95	12	22	240	16	69	36	<2
98BMF 102A1-e	620	690	<2	66	9	17	230	14	52	27	<2
98BMF 102A1-f	750	730	<2	56	8	14	37	14	34	23	<2
98BMF 102A1-g	810	780	<2	50	6	8	25	11	30	20	<2
98BMF 102A1-h	2100	710	<2	41	7	12	29	12	23	21	<2

Field Number	Nb ppm	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm
98BMF 102A1-a	19	24	9	1200	14	85	22	110	17	2	7100
98BMF 102A1-b	31	50	77	150	23	180	39	180	38	4	1500
98BMF 102A1-c	30	73	19	160	23	170	39	200	75	7	1500
98BMF 102A1-d	26	48	12	96	13	320	20	110	45	4	770
98BMF 102A1-e	25	38	9	66	10	340	18	65	25	3	190
98BMF 102A1-f	22	19	8	56	8	340	19	55	11	1	97
98BMF 102A1-g	20	16	6	35	6	340	14	38	9	1	75
98BMF 102A1-h	19	16	7	49	6	300	14	54	9	1	89

Table 6 Total-digestion concentration data from bed-sediment samples near Buckeye flotation tailings, upper Basin Creek, Montana

Field Number	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm	As ppm
98-BMS-104	7.7	2.3	11	2.3	1.1	1.5	0.19	0.75	1500	<2	45
97-BM-101-19	8.3	2.6	18	2.4	1.2	1.9	0.27	1.0	2700	<2	380
97-BM-101-A7	8.4	2.3	12	2.4	1.1	1.6	0.19	0.68	1800	7	880
97-BM-101-B7	8.3	2.5	15	2.3	1.3	1.8	0.24	0.99	2100	7	4000
97-BM-101-C7	7.6	2.3	30	2.3	1.1	1.5	0.26	1.3	2900	17	4200
96-BM-136	7.9	2.0	7.5	2.0	1.2	1.3	0.17	0.55	2000	5	4500
Field Number	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm	Nb ppm
98-BMS-104	630	<2	160	18	110	27	19	83	31	3	15
97-BM-101-19	460	<2	250	23	200	100	22	140	38	3	20
97-BM-101-A7	460	<2	160	20	110	76	17	91	37	3	21
97-BM-101-B7	480	<2	230	22	160	130	19	130	40	4	25
97-BM-101-C7	480	<2	280	20	310	190	23	160	38	3	13
96-BM-136	410	5	110	23	58	130	20	69	39	<2	26
Field Number	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm	
98-BMS-104	60	23	91	20	310	40	480	33	2	270	
97-BM-101-19	110	28	210	21	340	72	820	50	6	670	
97-BM-101-A7	74	19	460	19	320	44	480	38	4	510	
97-BM-101-B7	99	22	1500	22	330	62	670	46	5	660	
97-BM-101-C7	120	28	2200	20	280	50	1300	50	5	860	
96-BM-136	49	17	1600	20	270	29	220	41	4	820	

Table 7 Partial-digestion data (2M HCl-1% H₂O₂) from bed-sediment samples near Buckeye flotation tailings, upper Basin Creek, Montana

Field No	Al ppm	Ca ppm	Fe ppm	K ppm	Mg ppm	Na ppm	P ppm	Si ppm	Ti ppm	Mn ppm	Ag ppm
98-BMS-104	4500	4300	16000	1000	2900	90	1500	1100	360	620	<1
97-BM-101-19	6600	7500	22000	1100	3600	43	2900	1500	530	1700	1
97-BM-101-A7	6200	6200	21000	1100	3400	36	2100	1400	500	1200	3.0
97-BM-101-B7	5100	5500	20000	960	2900	37	2100	1200	560	1000	6.5
97-BM-101-C7	4700	5000	28000	730	2200	48	2000	1200	450	1200	8.6
96-BM-136	7300	6000	33400	1600	4800	51	1600	1400	700	1700	6.9
Field No	As ppm	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	La ppm	Li ppm	Mo ppm	Ni ppm
98-BMS-104	34	58	<1	43	5.8	6.0	16	20	9.4	<1	6.4
97-BM-101-19	170	55	3	87	17	11	61	46	13	2	8.7
97-BM-101-A7	600	56	2	66	16	8.4	50	37	13	1	6.8
97-BM-101-B7	3000	56	2	60	12	8.4	79	33	9.9	1	6.0
97-BM-101-C7	3000	64	3.2	63	10	8.0	99	36	7.7	1	5.0
96-BM-136	4000	86	5.0	56	14	11	120	32	17	<1	8.3
Field No	Pb ppm	Sb ppm	Sr ppm	Th ppm	V ppm	Y ppm	Zn ppm				
98-BMS-104	64	<3	16	11	34	12	160				
97-BM-101-19	160	<3	24	15	42	24	500				
97-BM-101-A7	410	<3	20	11	39	19	390				
97-BM-101-B7	1200	33	21	9.0	36	16	350				
97-BM-101-C7	1600	40	20	5.8	35	18	460				
96-BM-136	1600	34	37	7.4	51	20	680				

Table 8 Total-digestion data from residues following 2M HCl-1%H₂O₂ leach of bed-sediment samples near Buckeye flotation tailings, upper Basin Creek, Montana

Field Number	Al %	Ca %	Fe %	K %	Mg %	Na %	P %	Ti %	Mn ppm	Ag ppm	As ppm
98-BMS-104	7.0	1.8	11	2.1	0.71	1.5	0.02	0.78	700	<2	44
97-BM-101-19	6.3	1.4	16	1.8	0.64	1.3	0.02	0.87	810	<2	170
97-BM-101-A7	7.4	1.5	9.5	2.1	0.66	1.4	0.02	0.61	530	<2	250
97-BM-101-B7	6.1	1.4	12	1.7	0.67	1.2	0.02	0.81	740	<2	350
97-BM-101-C7	4.4	1.0	21	1.4	0.47	0.96	0.02	0.95	900	<2	370
96-BM-136	7.0	1.6	4.9	1.9	0.79	1.4	0.02	0.53	490	<2	410
Field Number	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm	Nb ppm
98-BMS-104	500	<2	120	15	120	2	19	76	18	<2	33
97-BM-101-19	280	<2	96	9	170	21	16	54	16	3	24
97-BM-101-A7	330	<2	70	8	95	18	16	38	20	2	28
97-BM-101-B7	280	<2	100	8	120	23	14	57	17	<2	30
97-BM-101-C7	240	<2	100	6	220	27	20	57	13	<2	10
96-BM-136	350	<2	75	8	52	19	15	44	20	<2	26
Field Number	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	Th ppm	V ppm	Y ppm	Yb ppm	Zn ppm	
98-BMS-104	44	20	10	18	300	36	520	22	2	70	
97-BM-101-19	43	12	38	14	230	20	700	22	3	110	
97-BM-101-A7	32	9	34	15	260	23	410	20	2	100	
97-BM-101-B7	39	11	60	14	220	26	530	21	3	180	
97-BM-101-C7	46	12	79	11	160	22	930	17	2	140	
96-BM-136	26	8	48	17	260	19	200	20	2	150	

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Appendix

TABLE A1 Comparison of contract laboratory results with NIST values for SRM-2704

SRM-2704 n=20					
Element	observed conc.	observed % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	5.71	2.8	6.11	0.16	93
Ca %	2.61	5.6	2.6	0.03	100
Fe %	3.73	3.9	4.11	0.10	91
K %	1.84	4.9	2.00	0.04	92
Mg %	1.12	3.3	1.2	0.02	93
Na %	0.56	4.8	0.55	0.014	102
P %	0.08	8.1	0.099	0.003	81
Ti %	0.33	5.3	0.457	0.018	72
Mn, ppm	550	4.3	555	19	99
Ag, ppm	<2				
As, ppm	33.6	60	23.4	0.8	144
Ba, ppm	405	14	414	12	98
Cd, ppm	<2		3.45	0.22	
Ce, ppm	62	3.7	72		86
Co, ppm	10.9	0.7	14	0.6	78
Cr, ppm	76.6	20	135	5	57
Cu, ppm	88.9	5.5	98.6	5	90
Ga, ppm	10.9	3.5	15		73
La, ppm	29.2	0.8	29		101
Li, ppm	39.5	1.3	50		79
Mo, ppm	3.6	0.5			
Nb, ppm	6.2	3.8			
Nd, ppm	28.9	1.3			
Ni, ppm	38.4	1.8	44	3	87
Pb, ppm	161	20	161	17	100
Sc, ppm	10.6	0.5	12		88
Sr, ppm	125	4.5	130		96
Th, ppm	7.4	2	9.2		80
V, ppm	88.4	9.8	95	4	93
Y, ppm	18.9	0.9			
Yb, ppm	2.1	0.3	2.8		75
Zn, ppm	375	22	438	12	86

* 95% confidence interval

This table shows the results for twenty analyses for SRM-2704 submitted as blind samples to the contract laboratory.

TABLE A2 Comparison of contract laboratory results with NIST values for SRM-2709

SRM-2709 n=20					
Element	observed conc.	observed % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	7.02	3.4	7.5	0.06	94
Ca %	1.82	3.4	1.89	0.05	96
Fe %	3.26	3.4	3.50	0.11	93
K %	1.89	5.3	2.03	0.06	93
Mg %	1.41	5.1	1.51	0.05	93
Na %	1.11	6.5	1.16	0.03	96
P %	0.05	11	0.062	0.005	81
Ti %	0.35	2.8	0.342	0.024	102
Mn, ppm	482	4.80	538	17	90
Ag, ppm	<2		0.41	0.03	
As, ppm	27.7	14	17.7	0.8	156
Ba, ppm	903	24	968	40	93
Cd, ppm	<2		0.38	0.01	
Ce, ppm	42.6	2.1	42		101
Co, ppm	10.6	0.7	13.4	0.7	79
Cr, ppm	41.2	16	130	4	32
Cu, ppm	30.1	1.3	34.6	0.7	87
Ga, ppm	14.2		14		101
La, ppm	21.7	1.2	23		94
Li, ppm	47.5	1.3	50		95
Mo, ppm	<2		2		
Nb, ppm	8.1	4.6			
Nd, ppm	18.5	0.7	19		97
Ni, ppm	72.5	2.5	88	5	82
Pb, ppm	30	12	18.9	0.5	159
Sc, ppm	11	0.3	12		92
Sr, ppm	215	7.8	231	2	93
Th, ppm	9.8	0.8	11		89
V, ppm	108	8.3	112	5	96
Y, ppm	13.4	0.5	18		74
Yb, ppm	1.8	0.2	1.6		113
Zn, ppm	95.6	8.6	106	3	90

* 95% confidence interval

This table shows the results for twenty analyses for SRM-2709 submitted as blind samples to the contract laboratory.

TABLE A3 Comparison of contract laboratory results with NIST values for SRM-2711

SRM-2711 n=20					
Element	observed conc.	observed % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	6.33	2.79	6.53	0.09	97
Ca %	2.81	3.73	2.88	0.08	98
Fe %	2.70	1.75	2.89	0.06	93
K %	2.34	4.76	2.45	0.08	95
Mg %	0.99	3.62	1.05	0.03	94
Na %	1.16	4.30	1.14	0.03	101
P %	0.07	9.59	0.086	0.007	83
Ti %	0.29	1.69	0.306	0.023	96
Mn, ppm	575	4.1	638	28	90
Ag, ppm	4.5	15	4.63	0.39	97
As, ppm	93.8	13	105	8	89
Ba, ppm	747	21	726	38	103
Cd, ppm	34.6	4.9	41.7	0.25	83
Ce, ppm	70	6.6	69		101
Co, ppm	8	8.3	10		80
Cr, ppm	18.1	34	47		39
Cu, ppm	106	5.6	114	2	93
Ga, ppm	13.7	18	15		91
La, ppm	37.2	4.7	40		93
Li, ppm	24.1	4.1			
Mo, ppm	<2				
Nb, ppm	15	21			
Nd, ppm	31.1	2.9	31		100
Ni, ppm	17.8	4	20.6	1.1	86
Pb, ppm	1060	3.8	1162	31	91
Sc, ppm	8.8	4.2	9		98
Sr, ppm	236	2.3	245	0.7	96
Th, ppm	12.1	12	14		86
V, ppm	79.4	7.9	81.6	2.9	97
Y, ppm	23	4.3	25		92
Yb, ppm	2.9	11	2.7		107
Zn, ppm	304	3.9	350	4.8	87

* 95% confidence interval

This table shows the results for twenty analyses for SRM-2711 submitted as blind samples to the contract laboratory.

TABLE A4 Comparison of USGS laboratory results with NIST values for SRM-2704

SRM-2704 n=7	USGS conc.	USGS % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	6.04	2.5	6.11	0.16	99
Ca %	2.64	2.8	2.6	0.03	102
Fe %	4.07	2.5	4.11	0.10	99
K %	1.93	3.6	2.00	0.04	96
Mg %	1.20	0.0	1.2	0.02	100
Na %	0.61	4.1	0.55	0.014	110
P %	0.10	4.4	0.099	0.003	104
Ti %	0.29	11.5	0.457	0.018	64
Mn, ppm	580	5.6	555	19	105
Ag, ppm	<2				
As, ppm	23	19	23.4	0.8	98
Ba, ppm	406	3.9	414	12	98
Cd, ppm	<2		3.45	0.22	
Ce, ppm	60	9.5	72		83
Co, ppm	15.7	2.9	14	0.6	112
Cr, ppm	146	3.4	135	5	108
Cu, ppm	96	7.5	98.6	5	97
Ga, ppm	15	6.2	15		100
La, ppm	30.9	0.8	29		107
Li, ppm	46.7	1.3	50		93
Mo, ppm	<2				
Nb, ppm	14.3	14			
Nd, ppm	28.4	9.4			
Ni, ppm	42.3	2.7	44	3	96
Pb, ppm	149	6.7	161	17	93
Sc, ppm	11.7	3.4	12		98
Sr, ppm	133	4.5	130		102
Th, ppm	9.6	17	9.2		104
V, ppm	89	3.3	95	4	94
Y, ppm	23.3	5			
Yb, ppm	2	0	2.8		71
Zn, ppm	431	3.6	438	12	98

* 95% confidence interval

This table shows the results for seven analyses for SRM-2704 analyzed in-house in the USGS analytical laboratories in Denver, Co.

TABLE A5 Comparison of USGS laboratory results with NIST values for SRM-2709

SRM-2709 n=7	USGS conc.	USGS % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	7.26	1.6	7.5	0.06	97
Ca %	1.93	2.3	1.89	0.05	102
Fe %	3.47	1.3	3.50	0.11	99
K %	1.89	3.4	2.03	0.06	93
Mg %	1.49	2.4	1.51	0.05	98
Na %	1.20	4.5	1.16	0.03	103
P %	0.07	6.7	0.062	0.005	108
Ti %	0.32	1.4	0.342	0.024	93
Mn, ppm	537	1.9	538	17	100
Ag, ppm	<2		0.41	0.03	
As, ppm	18.7	20	17.7	0.8	106
Ba, ppm	895	2.6	968	40	92
Cd, ppm	<2		0.38	0.01	
Ce, ppm	41.3	4.0	42		98
Co, ppm	15.0	5.0	13.4	0.7	112
Cr, ppm	124.3	5.9	130	4	96
Cu, ppm	31.3	5.3	34.6	0.7	90
Ga, ppm	15.3	4.6	14		109
La, ppm	23.6	3.1	23		102
Li, ppm	53.6	2.6	50		107
Mo, ppm	<2		2		
Nb, ppm	14.3	18			
Nd, ppm	17.9	6.3	19		94
Ni, ppm	83.1	2.0	88	5	94
Pb, ppm	14.4	20	18.9	0.5	76
Sc, ppm	11.9	3.0	12		99
Sr, ppm	227	3.1	231	2	98
Th, ppm	10.7	8.2	11		97
V, ppm	110.0	0.0	112	5	98
Y, ppm	17.9	5.5	18		99
Yb, ppm	1.9	19	1.6		116
Zn, ppm	98.9	1.3	106	3	93

* 95% confidence interval

This table shows the results for seven analyses for SRM-2709 analyzed in-house in the USGS analytical laboratories in Denver, Co.

TABLE A6 Comparison of USGS laboratory results with NIST values for SRM-2711

SRM-2711 n=7	USGS conc.	USGS % RSD	NIST value	NIST C.I.*	PERCENT RECOVERY
Al %	6.39	3.3	6.53	0.09	98
Ca %	2.93	3.5	2.88	0.08	102
Fe %	2.86	3.2	2.89	0.06	99
K %	2.34	6.0	2.45	0.08	96
Mg %	1.04	4.7	1.05	0.03	99
Na %	1.21	5.3	1.14	0.03	107
P %	0.08	5.9	0.086	0.007	98
Ti %	0.26	3.5	0.306	0.023	84
Mn, ppm	677	14	638	28	106
Ag, ppm	3.6	14	4.63	0.39	77
As, ppm	100	6.6	105	8	95
Ba, ppm	688	4.7	726	38	95
Cd, ppm	37.3	1.9	41.7	0.25	89
Ce, ppm	67.4	4.1	69		98
Co, ppm	11.6	4.3	10		116
Cr, ppm	47.0	3.4	47		100
Cu, ppm	108	6.5	114	2	95
Ga, ppm	16.0	6.7	15		107
La, ppm	37.9	3.8	40		95
Li, ppm	26.7	4.8			
Mo, ppm	<2				
Nb, ppm	17.0	31			
Nd, ppm	28.9	4.3	31		93
Ni, ppm	19.6	2.5	20.6	1.1	95
Pb, ppm	1070	6.7	1162	31	92
Sc, ppm	9.3	4.9	9		103
Sr, ppm	244	3.7	245	0.7	100
Th, ppm	13.9	4.6	14		99
V, ppm	77.6	2.7	81.6	2.9	95
Y, ppm	26.9	5.0	25		107
Yb, ppm	2.7	17	2.7		101
Zn, ppm	353	5.4	350	4.8	101

* 95% confidence interval

This table shows the results for seven analyses for SRM-2711 analyzed in-house in the USGS analytical laboratories in Denver, Co.

TABLE A7 ICP-AES elements and their limits of determination

Element	Symbol	Total Digestion Procedure	HCl-H ₂ O ₂ Leach Procedure
Aluminum	Al	.005 %	30 ppm
Calcium	Ca	.005 %	30 ppm
Iron	Fe	.005 %	30 ppm
Potassium	K	.01 %	30 ppm
Magnesium	Mg	.005 %	30 ppm
Sodium	Na	.005 %	30 ppm
Phosphorous	P	.005 %	30 ppm
Silicon	Si	--	30 ppm
Titanium	Ti	.005 %	30 ppm
Manganese	Mn	4 ppm	1.2 ppm
Silver	Ag	2 ppm	1.2 ppm
Arsenic	As	10 ppm	6 ppm
Barium	Ba	1 ppm	.6 ppm
Cadmium	Cd	2 ppm	1.2 ppm
Cerium	Ce	4 ppm	2.4 ppm
Cobalt	Co	1 ppm	.6 ppm
Chromium	Cr	1 ppm	.6 ppm
Copper	Cu	1 ppm	.6 ppm
Gallium	Ga	4 ppm	--
Lanthanum	La	2 ppm	1.2 ppm
Lithium	Li	2 ppm	2 ppm
Molybdenum	Mo	2 ppm	1.2 ppm
Niobium	Nb	4 ppm	--
Neodymium	Nd	4 ppm	--
Nickel	Ni	2 ppm	1.2 ppm
Lead	Pb	4 ppm	2.4 ppm
Antimony	Sb	--	3.0 ppm
Scandium	Sc	2 ppm	--
Strontium	Sr	2 ppm	1.2 ppm
Thorium	Th	4 ppm	2 ppm
Vanadium	V	2 ppm	1.2 ppm
Yttrium	Y	2 ppm	1.2 ppm
Ytterbium	Yb	1 ppm	--
Zinc	Zn	2 ppm	.6 ppm

Discussion of results in tables A1 through A6

The ICP-AES analyses of the core samples were done by an outside laboratory; the analyses of the bed-sediment samples were done in-house in the USGS laboratories in Denver, Colorado. The results from the contract laboratory are generally acceptable, but there are several notable exceptions. The recoveries were somewhat less accurate, and the variances were higher for samples run by the contract laboratory than for those run by the USGS laboratory. Arsenic is biased high below 100 ppm, and somewhat low above 100 ppm, relative to recommended NIST values. No recommendations are presented to normalize these analyses; at the high As levels contained in the cores, the values are acceptable. Cobalt is biased low, but is not an important element in this study. Chromium recoveries are very low, due to incomplete digestion, and we do not recommend using the chromium analyses. Lead shows a high bias at levels below 50 ppm, is relatively neutral at several hundred ppm, and shows a low bias at levels greater than 1,000 ppm. The analyses are still quite acceptable for the purpose of this report. The values for titanium from both laboratories tend to be low, due to the refractory nature of titanium oxides, which may not be completely dissolved in this acid digestion.